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# **Maricopa County Air Monitoring Network Assessment 2015-2019**



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## Executive Summary

The U.S. Environmental Protection Agency (EPA) amended the air monitoring regulations in 40 CFR 58.10(e) in 2006 to include a requirement that all state and local air monitoring agencies prepare an assessment of their monitoring networks once every five years. The purpose of this Network Assessment (Assessment) is to evaluate whether:

1. The monitoring network meets the monitoring objectives defined in the EPA monitoring regulations,
2. Whether new sites are needed or should be changed, and
3. If sites are no longer needed and can be terminated.

Following the procedures described below, this Assessment fulfills these requirements by using a variety of indicators to evaluate the ability of the existing network to achieve, within available resources, the best possible scientific value and protection of public and environmental health and welfare. This Assessment covers the time period of 2015-2019 and uses data from state, local and tribal air monitoring agencies within Maricopa County and the surrounding area.

Section 2 of the Assessment provides details on each of the monitoring sites within the Maricopa County Air Quality Department's (MCAQD) network; this includes a listing of their operation scale, objective, and a map/aerial photograph of the monitored area.

Section 3 performs a site-by-site comparison of the existing network; sites are ranked by a variety of analyses designed to give a comprehensive view of the network. These analyses are then weighted and combined to find the comparative rank of each site for each parameter. The analyses used are:

- |                                   |   |
|-----------------------------------|---|
| 1. Number of Parameters Monitored | 7. Monitor-to-Monitor Correlation                               |
| 2. Trends Impact                  | 8. Removal Bias   |
| 3. Measured Concentrations        | 9a. Emissions Inventory   |
| 4. Deviation from the NAAQS       | 9b. Predicted Ozone (ranked with O <sub>3</sub> parameter only) |
| 5. Area Served                    | 10. Traffic Counts  |
| 6. Population Served              | 11. Environmental Justice-Minority Population Served            |

Section 4 uses a series of raster-based maps that identify the relative strength of air monitoring coverage of urban areas within Maricopa County. Each map is created using differing analyses and a spatial score is created with a higher score meaning the area could have greater priority for monitoring coverage. The maps from these individual analyses are then weighted, spatially averaged, and combined to give an overall representation of how the area could benefit from additional monitoring coverage. The analyses used to create these maps are:

- |                                       |  |
|---------------------------------------|--|
| 1. Emissions Inventory – Point-Source | 4. Environmental Justice-Minority Population Density |
| 2. Traffic Counts-Mobile Source       | 5. Euclidean Distance                                |
| 3. Population Density                 | 6. Standard Error Prediction Map                     |

Section 5 uses the data generated in the previous sections to support a discussion of whether monitoring sites could be added, relocated, changed or terminated. Tables i through iv summarize this information for each of the criteria pollutants monitored by MCAQD.

This Assessment confirms that the current MCAQD network substantially meets all federally required monitoring objectives. However, as ambient air monitoring objectives have shifted over time (e.g. air quality has improved, new air quality objectives and standards have been strengthened), MCAQD may wish to consider the findings of this Assessment during future Air Monitoring Network Planning exercises to determine whether or how to reconfigure and optimize its monitoring network to enhance its value to stakeholders, scientists and the general public.

**Table i.** Summary of assessment results for the CO and NO<sub>2</sub> parameters. *Information about the results is given in italics.*

	CO	NO <sub>2</sub>
Monitors Considered for Closing	None.	None.
Monitors Considered for Moving or Changing	<p>1. Move the Thirty-Third near-road CO monitor to the Diablo replacement site when that is opened.</p> <p><i>The Diablo site was closed due to road construction in January 2020 and the CO monitor was temporarily moved to our secondary near-road site, Thirty-Third. It is recommended to move the CO monitor back to the Diablo replacement site when that is opened (currently planned for late 2020 or early 2021).</i></p>	<p>1. Diablo NO<sub>2</sub> monitor moved to replacement site when construction is finished (see narrative).</p> <p><i>When the Diablo site was closed in January 2020 the near-road NO<sub>2</sub> monitor there was temporarily taken offline. When the Diablo replacement site opens (currently planned for late 2020 or early 2021) it is necessary to bring the near-road NO<sub>2</sub> monitor back online.</i></p>
Potential New Monitors	None.	<p>None (see below).</p> <p><i>Though new permanent monitoring sites aren't recommended, it is recommended to explore patterns of NO<sub>2</sub> using temporary low-cost sensors (see Section 5.7). Increased knowledge of these NO<sub>2</sub> patterns, along with VOC patterns, will help with understanding the dynamics of ozone creation.</i></p>

**Table ii.** Summary of assessment results for the O<sub>3</sub> parameter. *Information about the results is given in italics.*

	O <sub>3</sub>
Monitors Considered for Closing	None.
Monitors Considered for Moving or Changing	<p>1. Change Mesa objective from 'Population Exposure' to 'Maximum Ozone Concentration'.</p> <p><i>This site has had the highest design value over the last five years is now representative of being downwind of the urban precursor emissions area and an area of maximum ozone formation</i></p>
	<p>2. Change Falcon Field objective from 'Population Exposure' to 'Maximum Ozone Concentration'.</p> <p><i>This site has had the 4<sup>th</sup> highest design value over the last five years and is now representative of being downwind of the urban precursor emissions area and an area of maximum ozone formation</i></p>
	<p>3. Change Blue Point objective from 'Max Ozone Concentration' to 'Extreme Downwind'.</p> <p><i>Concentration averages have decreased over the years in this area and 'Downwind' is a better objective for this site as it now characterizes the extreme downwind transported ozone exiting the metropolitan region.</i></p>
Potential New Monitors	None.

**Table iii.** Summary of assessment results for the PM<sub>10</sub> and PM<sub>2.5</sub> parameters. *Information about the results is given in italics.*

	PM <sub>10</sub>	PM <sub>2.5</sub>
Monitors Considered for Closing	None	None.
Monitors Considered for Moving or Changing	<p>1. West 43<sup>rd</sup> Avenue scale changed from 'Middle' to 'Neighborhood'.</p> <p><i>Based upon correlation analysis, source changes in the area, and inspection of aerial photographs, West 43<sup>rd</sup> Avenue now represents a broader scale than it did in the past. There is a relatively fair correlation between the West 43<sup>rd</sup> Avenue and Durango Complex sites, which are 3.3 km apart. This correlation is likely due to the same sources impacting both sites which indicates that the monitoring scale is larger than the 100-500 m of the 'Middle' classification.</i></p>	<p>1. Move the 'Thirty-Third near-road PM<sub>2.5</sub> monitor to the Diablo replacement site when that is opened.</p> <p><i>The Diablo site was closed due to road construction in January 2020 and the PM<sub>2.5</sub> monitor was temporarily moved to our secondary near-road site, Thirty-Third. It is recommended to move the PM<sub>2.5</sub> monitor back to the Diablo replacement site when that is opened (currently planned for late 2020 or early 2021) as highway traffic volumes are greater in that area.</i></p>
Potential New Monitors	None.	<p>None (see below)</p> <p><i>Though new permanent monitoring sites aren't recommended, it is recommended to continue to explore patterns of PM<sub>2.5</sub> using temporary low-cost sensors (see Section 5.7).</i></p>

**Table iv.** Summary of assessment results for the SO<sub>2</sub> and Pb parameters. *Information about the results is given in italics.*

	SO <sub>2</sub>	Pb
Monitors Considered for Closing	None.	None, all MCAQD Pb monitors are now closed.
Monitors Considered for Moving or Changing	1. Change Central Phoenix scale from 'Neighborhood' to 'Urban' <i>SO<sub>2</sub> concentrations from Central Phoenix, Durango Complex and the JLG Supersite are very low and range together, showing that SO<sub>2</sub> concentrations are consistent with a larger scale such as 'Urban'.</i>	None, all MCAQD Pb monitors are now closed.
	2. Change Durango Complex scale from 'Middle' to 'Neighborhood'. <i>Durango Complex has multiple SO<sub>2</sub> sources within several km of the site making 'Neighborhood' (ranging from 0.5-4.0 km) more appropriate than the current 'Middle' scale (ranging from 100-500 m).</i>	
Potential New Monitors	None.	None.

## Glossary of Terms

Term/ Acronym	Definition
ACS Census	American Community Survey by the U.S. Census Bureau: an ongoing survey that collects demographic data in between the decennial census.
ADEQ	Arizona Department of Environmental Quality
AQS	EPA's Air Quality System database
Attainment	Compliance with the NAAQS of the federal Clean Air Act: After several years with no violations of the NAAQS, an agency can request that the EPA reclassify the area as being "in attainment" for that pollutant.
AADT	Annual Average Daily Traffic count: The total annual vehicle volume of a highway or road divided by 365 days.
CFR	Code of Federal Regulations
Class I	A Federally designated park or wilderness area with mandated visibility protection requirements.
CO	Carbon monoxide
Continuous Monitoring	A method of monitoring air pollutants that is continually measuring the quantity of the pollutant, either gaseous or particulate. Continuous monitors can be used to obtain real-time or short-term averages of pollutants.
Criteria Pollutants	Six pollutants (CO, Pb, NO <sub>2</sub> , O <sub>3</sub> , particulates, and SO <sub>2</sub> ) for which NAAQS have been established by the EPA.
Design Value	A statistic that describes the air quality status of a given area relative to the level of the NAAQS. For a concentration-based standard, the air quality design value is simply the standard-related test statistic. The design value of a pollutant monitoring network is the highest sample value in the network used to compare to the NAAQS (e.g., the 24-hour PM <sub>2.5</sub> design value for the network is the monitor with the highest 3-year average of the 98 <sup>th</sup> percentile).
Emissions Inventory	An accounting of the amount of pollutants discharged into the atmosphere. An emission inventory usually contains the total emissions for one or more specific air pollutants, originating from all source categories within a defined geographic area and for a specific time span (often a specific calendar year).
Environmental Justice	The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

EPA	U. S. Environmental Protection Agency.
Euclidean Distance	The straight-line distance between two points.
FEM	Federal Equivalency Method: An official method, i.e. equipment and procedure, of monitoring air pollution that has been determined to produce results similar to the Federal Reference Method (FRM).
Filter-based Monitor	A method of monitoring particulate pollution that involves exposing a pre-weighed filter to a specific flow volume of air to capture the particulates in the air. The filters are then post-weighed to determine the weight of particulates per volume, e.g. $\mu\text{g}/\text{m}^3$ . Filter-based monitors used by MCAQD are all FRM monitors.
FRM	Federal Reference Method: An official method, i.e. equipment and procedure, of monitoring air pollution that has been tested and determined to produce results that accurately measure air pollution with acceptable precision. These methods are the baseline that all other methods, e.g. Federal Equivalency Methods (FEM), refer to.
GIS	Geographic Information System (e.g. ArcGIS)
Kriging	A group of geostatistical techniques to interpolate the value of a random field at an unobserved location, based upon observations of its value at nearby locations.
MAG	Maricopa Association of Governments
MCAQD	Maricopa County Air Quality Department
NAAQS	National Ambient Air Quality Standards. A set of health- and welfare-based standards set by the EPA to qualify allowable levels of criteria pollutants.
NO <sub>2</sub>	Nitrogen dioxide
NO <sub>x</sub>	Nitrogen oxides: Sum of nitric oxide (NO), NO <sub>2</sub> , and other oxides of nitrogen.
O <sub>3</sub>	Ozone
Pb	Lead
PLSS	Public Land Survey System, aka the Rectangular Survey System: The surveying method developed and used in the United States to describe and subdivide land. Typically uses common terms such as township, range, and section.
PM	Particulate matter: Material suspended in the air in the form of minute solid particles or liquid droplets.
PM <sub>2.5</sub>	Particulate matter of 2.5 micrometers (2.5 $\mu$ ) or smaller in diameter.

PM <sub>10</sub>	Particulate matter of 10 micrometers (10 μ) or smaller in diameter.
PPM	Parts per million.
Raster	In its simplest form, a raster consists of a matrix of cells (or pixels) organized into rows and columns (or a grid) where each cell contains a value representing information, such as temperature or pollution value.
Removal Bias	The difference between the actual pollutant value from the monitoring site and the predicted pollutant value from the interpolation map used as an absolute value.
SO <sub>2</sub>	Sulfur dioxide
SPM	Special purpose monitor: Monitors that provide data for special studies needed by state and local agencies, including support of State Implementation Plans (SIPs) and other air program activities. SPMs are not permanently established and can be adjusted easily to accommodate changing needs and priorities.
TEOM	Tapered Element Oscillating Microbalance: A continuous monitoring instrument used to measure PM.
Thiessen Polygon	Polygons whose boundaries define the area that is closest to each point relative to all other points (also known as Voronoi polygons). They are mathematically defined by the perpendicular bisectors of the lines between all points and define individual areas of influence around each of a set of points.
VOCs	Volatile organic compounds. VOCs are chemical compounds that can easily vaporize and enter the atmosphere. There are many natural and artificial sources of VOCs; solvents and gasoline make up some of the largest artificial sources. VOCs react with NO <sub>x</sub> in the presence of sunlight to create ground-level O <sub>3</sub> pollution.

## Section 1: Introduction

### 1.1 Overview of this report

The U.S. Environmental Protection Agency (EPA) amended the ambient air monitoring regulations on October 17, 2006 to include a requirement for state and local agencies to perform an assessment of their monitoring networks once every five years. The purpose of the network assessment (as detailed in 40 CFR 58.10(d)) is *“to determine, at a minimum, if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation in to the ambient air monitoring network.”*

A network assessment includes:

- (1) Re-evaluation of the objectives and budget for air monitoring,
- (2) evaluation of a network’s effectiveness and efficiency relative to its objectives and costs, and
- (3) development of recommendations for network reconfigurations and improvements.

To achieve the above objectives, the analyses contained in the subsequent sections of this Assessment are presented as follows:

Section 2 – Provides details of each MCAQD monitoring site, including specific information on the pollutants measured, and lists key equipment located at each site.

Section 3 – Provides a monitor-to-monitor comparison of the existing network using a series of assessments. These comparisons rank each site against each other to determine its comparative-value. Finally, each assessment is assigned a weight, and each site within the MCAQD monitoring network is then ranked by the weighted average of the analyses. These rankings are then used for subsequent analyses, including assessing which sites may no longer be needed and can be terminated.

Section 4 – Evaluates whether the existing monitoring network adequately assesses potential air pollution problems, and if it does not, suggests where additional sites may be considered. This evaluation is done using a series of raster-based maps representing a variety of indicators. The maps are reclassified into a congruous ranking system and organized into three areas: source-oriented, population-oriented, and spatially oriented. Each indicator is then assigned a weight, and the spatial average of each weighted indicator computed. This spatial average is then used to weigh the optimal locations at which new monitors may be considered.

Section 5 – Describes potential monitoring network changes based upon the evaluations described in the preceding sections. Considerations of whether to add additional sites, move, or discontinue existing sites reflect a variety of parameters considered in the preceding evaluations, such as population count, pollution sources, monitoring history, compliance with air quality standards, and environmental justice concerns.

### 1.2 Parameters Assessed

This Assessment will address the criteria pollutants monitored by MCAQD during the period 2015-2019, i.e. carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO<sub>2</sub>), ozone (O<sub>3</sub>), particulate matter (both particulate matter <10 micrometers [PM<sub>10</sub>] and particulate matter <2.5 micrometers [PM<sub>2.5</sub>]) and sulfur dioxide (SO<sub>2</sub>).

### 1.3 Assessment Methodology

A number of different analyses are used in assessing the effectiveness of the existing monitoring sites. These analyses were chosen to represent a number of variables; however, each analysis is not necessarily of equal importance. To reflect this variability among factors addressed in this Assessment, MCAQD has assigned a weight of relative importance; each analysis will then be ranked using this weighted average. This process is repeated for each criteria pollutant addressed in this assessment.

Table 1.1 describes the analyses used in Section 3 of the assessment. The parameters outlined in this table have been used to evaluate the monitoring network and conduct the site-by-site comparison.

**Table 1.1.** Analyses used in Section 3 of this Network Assessment.

#	Analysis	Description of Analysis Technique
1	Number of Parameters Monitored	Multiple pollution parameters monitored at a site make that site more valuable, as the site is more cost-effective, and colocated pollutant measurements can be compared together. This analysis is the primary indicator of economic value of a site.
2	Trends Impact	This analysis ranks sites by the length of their continuous monitoring records. Monitors that have a long historical record are more valuable for tracking long-term trends.
3	Measured Concentrations	This analysis ranks sites by their design value. Sites with higher concentrations are more important from a regulatory perspective.
4	Deviation from the NAAQS	This analysis ranks sites by how close they are to the National Ambient Air Quality Standards (NAAQS). This analysis recognizes sites that are close to the NAAQS are important and could more easily influence compliance either way.
5	Area Served	Sites are ranked based on their area of coverage. Using the Thiessen polygon technique, spatial locations that are closest to an existing monitor are collected into one neighborhood polygon. The polygon with the largest area is most important.
6	Population Served	Using the Thiessen polygon technique, the number of people living within each polygon is calculated. Areas with higher population are ranked higher.
7	Monitor-to-Monitor Correlation	Measured concentrations at one monitor are compared to those measured at other monitors to determine if concentrations correlate temporally. Monitors with lower correlations have more unique value and thus are ranked
8	Removal Bias	Measured values for each individual pollutant were interpolated by the kriging method across the entire study area. Sites were systematically removed and then the interpolation was repeated. The difference between the measured concentration and the predicted concentration was then used to determine the removal bias. The greater a site's bias, the
9	Emissions Inventory	Emissions inventory data were used to spatially locate point emission sources. Total emissions were then aggregated using the Thiessen polygon technique for each monitoring site. The emissions were then normalized by using a density measure. Sites with greater emissions were ranked higher.
10	Traffic Counts	Similar to the Emissions Inventory analysis, the Traffic Counts analysis uses current Average Weekday Traffic (AWT) data from both highway and arterial roads within the study area. With the assumption that higher traffic density results in more pollution, the Thiessen polygon technique was used to assign the traffic density to each monitoring site. A second indicator of road density was also calculated for each polygon, and a weighted average was created. Sites with higher
11	Environmental Justice-Minority Population served	This analysis uses the same technique as the population served analysis, only minority population was used instead of total population. The Thiessen polygon with the highest total minority population ranked higher in this test.

Section 4 includes analyses similar to those in Section 3 and uses much of the same data sources, but these analyses use raster-based maps spatially averaged together with the purpose of identifying areas of air monitoring priorities. Table 1.2 describes the indicators used in Section 4.

**Table 1.2.** Analyses used in Section 4 of this Network Assessment.

#	Analysis	Description of Analysis Technique
1	Emissions Inventory – Point-Source Emissions	Using the emissions inventory maps from Section 3, this technique finds the areas of the highest point source pollution that are least represented by pollution monitors.
2	Traffic Counts-Mobile Source Emissions	Using maps of traffic density (on both highways and arterial roads) and road density, the highest areas of mobile source emissions are estimated. This technique then finds the areas that are least represented by pollution monitors.
3	Population Density	Using the population density maps from the Population Served analysis in Section 3, this technique identifies areas of high population density that are least represented by pollution monitors.
4	Environmental Justice-Minority Population Density	Similar to the Population Density measure above, this technique identifies areas of the highest minority population density and finds those areas that are least represented by pollution monitors.
5	Euclidean Distance	This technique measures the Euclidean distance between existing monitoring sites. The greater the distance to the nearest site, the more valuable an additional monitoring site would be.
6	Standard Error Prediction Map	Each pollution parameter has a kriging interpolation map created using the entire monitoring network; only instead of the normal predicted surface output, a standard error surface is created. The standard error output shows areas of greatest uncertainty in the kriging interpolation. This map is then compared with the other techniques in a spatially weighted average to find areas that would benefit the most from additional air monitors.

## 1.4 Data Sources

Raw air pollution data for all of the analyses were obtained from the EPA's Air Quality System (AQS) database. Data were extracted for the five-year period 2015-2019. Yearly and five-year averages were derived from the raw air pollution data. Other significant statistics were also calculated as needed, such as maximum values or the fourth-highest hourly O<sub>3</sub> concentration at a particular monitoring site.

Census data were obtained from the 2017 ACS Census and were converted to GIS data as necessary. Census data were obtained at the resolution of Census Block Group where applicable.

Emissions inventory data were obtained from the MCAQD Emissions Inventory Unit. These data were spatially located using the addresses of the inventory respondents. The individual emission reports were then aggregated by the township, range, and section system to create emissions by section. The latest available emissions inventory survey from 2018 was used, though survey results going back to 2004 were used to fill in blanks for currently operating businesses.

Traffic counts were obtained from the Maricopa Association of Governments (MAG), the Phoenix region's metropolitan transportation planning organization. MAG collects the traffic data from individual state, county and municipal transportation agencies. The latest count available at each point between 2002-2019 was used, though the majority of the 7,006 count locations were sampled in 2018-2019.

All Geographic Information System (GIS) data came exclusively from the Maricopa County government offices. The assessment used the most current geographic road data, which are from 2020.

## 1.5 Sites Used in This Network Assessment

This Assessment considers all monitoring sites reporting data to the AQS database that are located within Maricopa County or adjacent counties including those sites operated by the Arizona Department of Environmental Quality (ADEQ), other county air quality agencies, and tribal governments. Since most analytical assessments consider the spatial location of existing monitoring sites, it is logical to include sites operated by other agencies, especially since data from these sites are available in the AQS database. Inclusion of these other sites also greatly increases the power of kriging interpolations, which were frequently used in this assessment. However, only results evaluating MCAQD sites are displayed in this report.

The following tables list all of the sites used in this assessment, organized by their operating agencies. Note that the location and information about each one of these sites comes from the AQS database; site acronyms and local site names were not always listed or up to date in AQS. In these cases, an assumed site acronym or local name was created and is consistently used throughout this assessment. These site acronyms or local names might be different from that used by the individual agency, but that is unimportant as the site can always be referenced by the official AQS number which is listed on these tables.

**Table 1.3.** Monitoring sites operated by the Maricopa County Air Quality Department.

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O <sub>3</sub>	CO	NO <sub>2</sub>	SO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	Pb	
04-013-0019	WP	West Phoenix	39th Ave. & Earll Dr.	Phoenix	Maricopa	X	X	X		X	X		
04-013-1003	ME	Mesa	Broadway Rd. & Alma School Rd.	Mesa	Maricopa	X	X			X	X		
04-013-1004	NP	North Phoenix	7th Street & Dunlap Ave.	Phoenix	Maricopa	X	X			X	X		CO monitor closed March 2016
04-013-1010	FF	Falcon Field	McKellips & Greenfield Rd.	Mesa	Maricopa	X							
04-013-2001	GL	Glendale	59th Ave & W. Olive	Glendale	Maricopa	X	X			X	X		CO monitor closed March 2016
04-013-2005	PP	Pinnacle Peak	Pima Rd & Pinnacle Peak Rd.	Scottsdale	Maricopa	X							
04-013-3002	CP	Central Phoenix	16th St & Roosevelt St.	Phoenix	Maricopa	X	X	X	X	X			
04-013-3003	SS	South Scottsdale	Scottsdale Rd. & Thomas Rd.	Scottsdale	Maricopa	X	X			X			CO monitor closed March 2016
04-013-3010	GR	Greenwood	27th Ave. & Interstate 10	Phoenix	Maricopa		X	X		X			Site closed June 2016
04-013-4003	SP	South Phoenix	Central Ave. & Broadway Rd.	Phoenix	Maricopa	X	X			X	X		
04-013-4004	WC	West Chandler	Ellis St & Frye Rd.	Chandler	Maricopa	X	X			X			
04-013-4005	TE	Tempe	College Ave. & Apache Blvd.	Tempe	Maricopa	X	X			X	X		CO monitor closed March 2016
04-013-4006	HI	Higley	Higley Rd. & Chandler Blvd.	Gilbert	Maricopa					X			PM <sub>10</sub> monitor offline for site construction from October 2014 to March 2017
04-013-4008	CC	Cave Creek	32nd St. & Carefree Highway	Phoenix	Maricopa	X							
04-013-4009	WF	West 43rd Ave	43rd Ave. and Broadway Rd.	Phoenix	Maricopa					X			
04-013-4010	DY	Dysart	Dysart Rd & Bell Rd.	Surprise	Maricopa	X	X			X			CO monitor closed March 2016
04-013-4011	BE	Buckeye	Hwy 85 & MC 85	Buckeye	Maricopa	X	X	X		X			
04-013-4016	ZH	Zuni Hills	108th Ave. & Deer Valley Rd.	Sun City	Maricopa					X			

04-013-4018	DV	Deer Valley	10 <sup>th</sup> Ave. & Deer Valley Rd.	Phoenix	Maricopa							X	Site closed in December 2019
04-013-4019	DI	Diablo	1919 W Fairmont Dr.	Tempe	Maricopa		X	X			X		Site closed in January 2020 because of road construction; to be moved to a nearby location
04-013-4020	TT	Thirty-Third	Interstate 10 & Mooreland Rd.	Phoenix	Maricopa		X	X			X		Near-road monitoring site; opened in September 2015. CO and PM <sub>2.5</sub> monitors closed in March 2016 but reopened in January 2020.
04-013-9508	HM	Humboldt Mountain	N Seven Springs Rd. & Bartlett Lake Rd.	Not in a city	Maricopa	X							
04-013-9702	BP	Blue Point	Usery Pass Rd. & Bush Highway	Not in a city	Maricopa	X							
04-013-9704	FH	Fountain Hills	Palisades & Fountain Hills Blvd.	Fountain Hills	Maricopa	X							
04-013-9706	RV	Rio Verde	Forest Rd & Del Ray Ave.	Rio Verde	Maricopa	X							Site closed in October 2017
04-013-9812	DC	Durango Complex	27th Ave. & Durango St.	Phoenix	Maricopa				X	X	X		

**Table 1.4.** Monitoring sites operated by the Arizona Department of Environmental Quality.

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O <sub>3</sub>	CO	NO <sub>2</sub>	SO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	Pb	
04-007-0008	PW	Payson Well Site	204 W Aero Dr.	Payson	Gila					X			
04-007-0009	MR	Miami Ridgeline	4030 Linden Street	Miami	Gila				X	X			SO <sub>2</sub> monitor closed September 2017, PM <sub>10</sub> monitor closed September 2015
04-007-0010	TM	Tonto NM	South of SR88	—	Gila	X							
04-007-0011	MJ	Miami Jones Ranch	Cherry Flats Rd.	-	Gila				X				
04-007-0012	MT	Miami Townsite	Sullivan St & Davis Canyon	Miami	Gila				X				
04-007-1001	HJ	Hayden Old Jail	Jail-Canyon Dr.	Hayden	Gila				X	X			
04-007-1002	GW	Globe Highway	SR 77	-	Gila							X	
04-007-1003	HC	Hillcrest AMS	123 Hillcrest Ave	Hayden	Gila							X	Site opened January 2016
04-007-8000	FM	Miami Golf Course	SR 188 & US 60	Globe	Gila					X		X	

04-012-8000	AL	Alamo Lake	Alamo Lake State Park	Wenden	La Paz	X	X	X	X	X	X		CO monitor opened September 2016 and closed August 2018, SO <sub>2</sub> monitor closed March 2016, NO <sub>2</sub> monitor closed June 2016
04-013-9997	JS	JLG (Supersite)	4530 North 17th Avenue	Phoenix	Maricopa	X	X	X	X	X	X	X	
04-019-0001	AO	Ajo	AZ HWY Dept Yard-Well Rd	Ajo	Pima					X			
04-019-0020	RI	Rillito	8840 W Robinson Street	Rillito	Pima					X			
04-021-8001	QV	Queen Valley	10 S Queen Ann	Queen Valley	Pinal	X							
04-025-8033	PC	Prescott College AQD	330 Grove Avenue	Prescott	Yavapai	X							Site closed in December 2016. Monitor moved to 04-025-8034
04-025-8034	PK	Prescott Pioneer Park	1200 Commerce Dr.	Prescott	Yavapai	X							Site opened January 2017
04-027-8011	YS	Yuma Supersite	2323 S Arizona Ave	Yuma	Yuma	X				X	X		

**Table 1.5.** Monitoring sites operated by the Fort McDowell Yavapai Nation.

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O <sub>3</sub>	CO	NO <sub>2</sub>	SO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	Pb	
TT-613-5100	YF	Fort McDowell/Yuma	18791 Yuma Frank Road	Fort McDowell	Maricopa	X				X			

**Table 1.6.** Monitoring sites operated by the Gila River Indian Community.

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O <sub>3</sub>	CO	NO <sub>2</sub>	SO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	Pb	
TT-614-7003	SJ	St. Johns	4208 West Pecos	Laveen	Maricopa	X				X			
TT-614-7001	SN	Sacaton	35 Pima St	Sacaton	Pinal	X				X			
TT-614-7004	BL	Casa Blanca	Casa Blanca/Preschool Rd	Bapchule	Pinal					X			

**Table 1.7.** Monitoring sites operated by the Pima County Air Quality Department.

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O <sub>3</sub>	CO	NO <sub>2</sub>	SO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	Pb	
04-019-0008	CR	Corona De Tucson	22000 S Houghton Rd	Corona de Tucson	Pima					X			
04-019-0011	OG	Orange Grove	3401 W Orange Grove Rd	Tucson	Pima					X	X		
04-019-0021	SG	Saguaro Park	3905 S. Old Spanish Trail	Not in a city	Pima	X							
04-019-1001	ST	South Tucson	1601 S 6th Ave	South Tucson	Pima					X			PM <sub>10</sub> changed to continuous monitor October 2017
04-019-1011	CY	22nd & Craycroft	1237 S Beverly	Tucson	Pima	X	X	X					CO monitor closed March 2018
04-019-1014	AV	22nd & Alvernon	22nd & Alvernon	Tucson	Pima		X						
04-019-1018	TG	Tangerine	12101 N Camino De Oeste	Marana	Pima	X				X			
04-019-1020	FG	Fairgrounds	11330 S Houghton	Tucson	Pima	X							
04-019-1021	CG	Cherry & Glenn	2745 N Cherry	Tucson	Pima		X						Site closed March 2018
04-019-1026	SL	Santa Clara	6910 S Santa Clara Ave	Tucson	Pima					X			
04-019-1028	CI	Children's Park	400 W River Rd	Tucson	Pima	X	X	X	X		X	X	PM <sub>2.5</sub> changed to continuous monitor July 2017
04-019-1030	GV	Green Valley	601 N La Canada Dr	Green Valley	Pima	X				X			
04-019-1031	GF	Golf Links	2601 S Kolb Rd	Tucson	Pima		X						Site closed March 2018
04-019-1032	RE	Rose Elementary	710 W Michigan	Tucson	Pima	X							
04-019-1034	CE	Coachline	9597 N Coachline Blvd	Tucson	Pima	X							
04-019-1113	GO	Geronimo	2498 N Geronimo	Tucson	Pima					X			

**Table 1.8.** Monitoring sites operated by the Pinal County Air Quality Department.

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored								Notes
						O <sub>3</sub>	CO	NO <sub>2</sub>	SO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	Pb		
04-021-0001	CD	Casa Grande Downtown	401 N Marshall St	Casa Grande	Pinal					X	X		PM <sub>2.5</sub> continuous monitor added January 2015	
04-021-3001	AY	AJ Maintenance Yard	305 E Superstition Blvd	Apache Junction	Pinal	X								
04-021-3002	AF	AJ Fire Station	3955 E Superstition Blvd	Apache Junction	Pinal					X	X			
04-021-3003	CA	Casa Grande Airport	660 W Aero Dr.	Casa Grande	Pinal	X								
04-021-3004	CO	Coolidge	212 E Broadway	Coolidge	Pinal					X				
04-021-3007	AP	Pinal Air Park	Water Well #2 Pinal Air Park Rd	Marana	Pinal	X				X				
04-021-3008	SF	Stanfield	36697 W Papago Dr	Stanfield	Pinal					X				
04-021-3009	CB	Combs	301 E Combs Rd	Queen Creek	Pinal					X				
04-021-3010	MC	Maricopa	44625 W Garvey Rd	Maricopa	Pinal					X			Site closed December 2016	
04-021-3011	CH	Pinal County Housing	970 N Eleven Mile Corner Rd	Casa Grande	Pinal					X				
04-021-3013	CT	Cowtown	37580 W Maricopa-	Maricopa	Pinal					X	X		Site closed December 2015	
04-021-3014	EY	Eloy	801 N Main St	Eloy	Pinal					X				
04-021-3015	HV	Hidden Valley	43750 W. Carefree Place	Stanfield	Pinal					X	X		Site opened in January 2016	
04-021-3016	MA	Maricopa 1405	19955 N Wilson Ave	Maricopa	Pinal					X			Site opened in January 2017	

**Table 1.9.** Monitoring sites operated by the Salt River-Pima Maricopa Indian Community.

AQS Site Number	Site Abbr	Site Name	Address	City	County	Pollutants Monitored							Notes
						O <sub>3</sub>	CO	NO <sub>2</sub>	SO <sub>2</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	Pb	
TT-615-7020	SC	Senior Center	10844 East Osborn Road	Scottsdale	Maricopa	X				X	X		
TT-615-7021	RM	Red Mountain	15115 Beeline Highway	Scottsdale	Maricopa	X							
TT-615-7022	LE	Lehi	3230 North Stapley Drive	Scottsdale	Maricopa	X				X			Continuous PM <sub>10</sub> monitor replaced filter monitor in April 2018
TT-615-7024	HS	High School	4827 North Country Club Drive	Scottsdale	Maricopa	X				X			

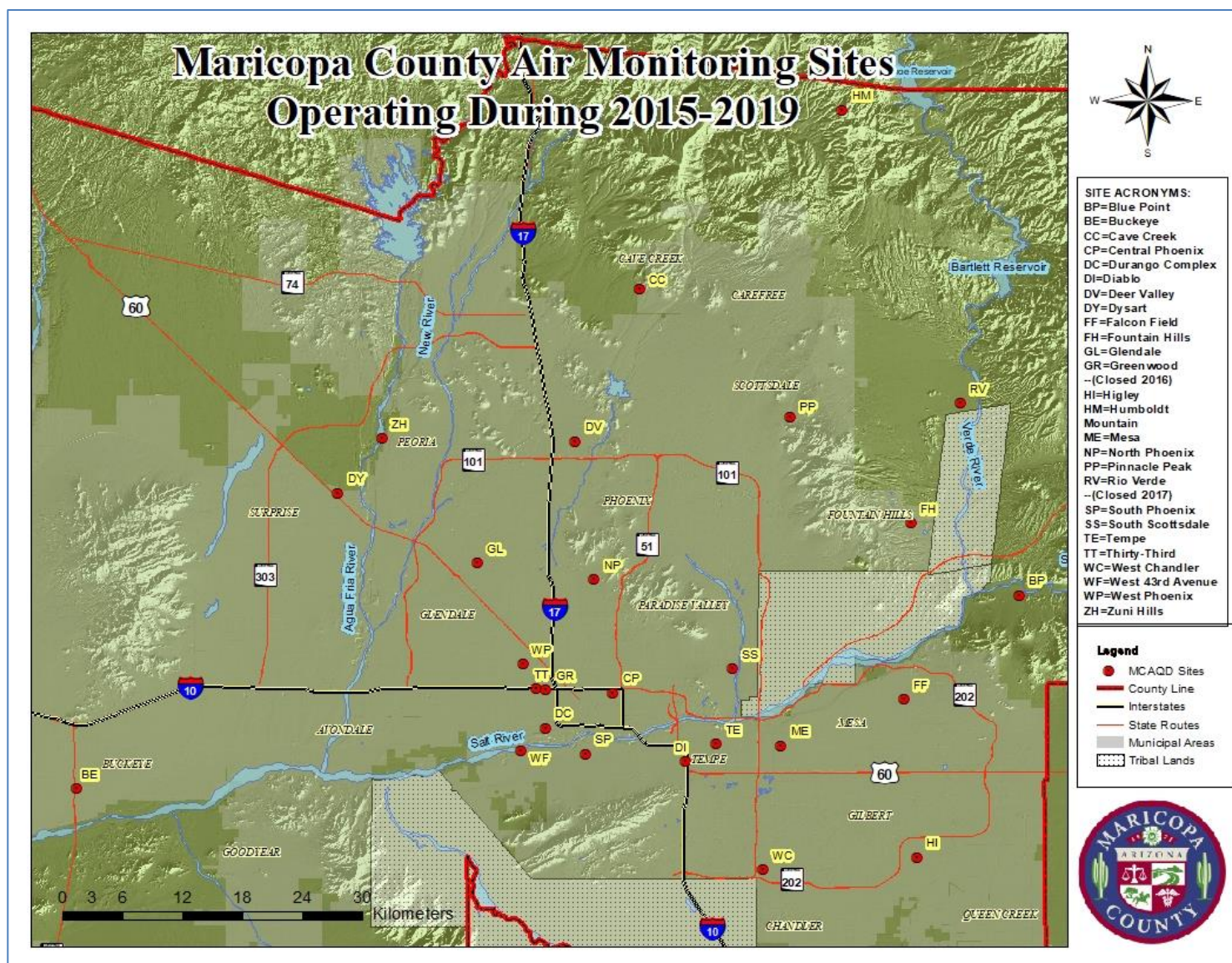
## Section 2: Background, Scale, and Objectives of the MCAQD Monitoring Network

This section includes descriptions of each of the monitoring sites within the MCAQD monitoring network during 2015-2019, including sites and monitors that are now closed but were operating during the study period. The criteria pollutant parameters monitored at each site are listed, as well as the date the monitor began operation. Each site listing includes an aerial photograph or map shown with a circular boundary that represents the assigned monitoring scale. This boundary is assumed to represent a relatively homogeneous air parcel, and the entire area is expected to be well represented by the monitoring site (though variable between the minimum and maximum boundaries).

Monitoring sites are each classified by their (1) monitoring scale and (2) objective. As previously mentioned, the monitoring scale is an assumed area of a relatively homogeneous air parcel. A monitoring objective is a specific purpose that the monitoring site is expected to fulfill. The following table demonstrates the scale and objective choices available:

**Table 2.1.** Monitoring site scales (A) and objectives (B)

<b>(A)</b>		<b>(B)</b>
<b>Scale</b>	<b>Defined parameter (radius)</b>	<b>Objective Examples</b>
Micro Scale	0 to 100 meters	Determine highest concentrations expected to occur in the area covered by the network.
Middle Scale	100 to 500 meters	Determine representative concentrations in areas of high population density.
Neighborhood Scale	0.5 to 4 kilometers	Determine the impact on ambient pollution levels of significant sources or source categories.
Urban Scale	4 to 50 kilometers	Determine general background concentration levels.
Regional Scale	10 to 100s of kilometers	Determine the extent of regional pollutant transport from populated areas, with regards to the secondary standards (such as visibility impairment and effects on vegetation).
		Determine the welfare-related impacts in more rural and remote areas.



**Figure 2.1.** Map of the Maricopa County Air Monitoring Network during 2015-2019. Note that this map includes two sites, Greenwood and Rio Verde, that closed during this period.

## 2.1 Summary of MCAQD Network's Scale and Objectives

The following tables detail the scale and objective status of MCAQD monitors as of December 2019.

**Table 2.2.** CO monitoring sites

Site	AQS#	Scale	Objective	Notes
Buckeye	04-013-4011	Neighborhood	Upwind background	
Central Phoenix	04-013-3002	Neighborhood	Population exposure	
Diablo	04-013-4019	Micro	Source oriented	
Dysart	04-013-4010	Neighborhood	Population exposure	Closed March 2016
Glendale	04-013-2001	Neighborhood	Population exposure	Closed March 2016
Greenwood	04-013-3010	Middle	Population exposure	Closed June 2016
Mesa	04-013-1003	Neighborhood	Population exposure	
North Phoenix	04-013-1004	Neighborhood	Population exposure	Closed March 2016
South Phoenix	04-013-4003	Neighborhood	Population exposure	
South Scottsdale	04-013-3003	Neighborhood	Population exposure	Closed March 2016
Tempe	04-013-4005	Neighborhood	Population exposure	Closed March 2016
Thirty-Third	04-013-4020	Micro	Source oriented	Opened Sep. 2015, closed March 2016, reopened Jan. 2020
West Chandler	04-013-4004	Neighborhood	Population exposure	
West Phoenix	04-013-0019	Neighborhood	Highest concentration	

**Table 2.3.** NO<sub>2</sub> monitoring sites

Site	AQS#	Scale	Objective	Notes
Buckeye	04-013-4011	Urban	Upwind background	
Central Phoenix	04-013-3002	Neighborhood	Highest concentration	
Diablo	04-013-4019	Micro	Source oriented	Closed Jan. 2020, to be moved to nearby location in late 2020 or early 2021.
Greenwood	04-013-3010	Middle	Population exposure	Closed June 2016
Thirty-Third	04-013-4020	Micro	Source oriented	Opened Sep. 2015
West Phoenix	04-013-0019	Neighborhood	Population exposure	

**Table 2.4.** O<sub>3</sub> monitoring sites

Site	AQS#	Scale	Objective	
Blue Point	04-013-9702	Urban	Maximum Ozone Concentration	
Buckeye	04-013-4011	Urban	Upwind background	
Cave Creek	04-013-4008	Urban	Maximum Ozone Concentration	
Central Phoenix	04-013-3002	Neighborhood	Population exposure	
Dysart	04-013-4010	Neighborhood	Population exposure	
Falcon Field	04-013-1010	Neighborhood	Population exposure	
Fountain Hills	04-013-9704	Neighborhood	Population exposure	
Glendale	04-013-2001	Neighborhood	Population exposure	
Humboldt Mountain	04-013-9508	Regional	Extreme downwind	
Mesa	04-013-1003	Neighborhood	Population exposure	

North Phoenix	04-013-1004	Neighborhood	Maximum Ozone Concentration	
Pinnacle Peak	04-013-2005	Urban	Maximum Ozone Concentration	
Rio Verde	04-013-9706	Urban	Maximum Ozone Concentration	Closed Oct. 2017
South Phoenix	04-013-4003	Neighborhood	Population exposure	
South Scottsdale	04-013-3003	Neighborhood	Population exposure	
Tempe	04-013-4005	Neighborhood	Population exposure	
West Chandler	04-013-4004	Neighborhood	Population exposure	
West Phoenix	04-013-0019	Neighborhood	Population exposure	

**Table 2.5.** SO<sub>2</sub> monitoring sites

Site	AQS#	Scale	Objective	
Central Phoenix	04-013-3002	Neighborhood	Highest concentration	
Durango Complex	04-013-9812	Middle	Highest concentration	

**Table 2.6.** Pb monitoring sites

Site	AQS#	Scale	Objective	Notes
Deer Valley	04-013-4018	Middle	Source oriented	Closed in December 2019

**Table 2.7.** PM<sub>10</sub> monitoring sites

Site	AQS#	Scale	Objective	Notes
Buckeye	04-013-4011	Neighborhood	Population exposure	
Central Phoenix	04-013-3002	Neighborhood	Population exposure	
Durango Complex	04-013-9812	Neighborhood	Population exposure	
Dysart	04-013-4010	Neighborhood	Population exposure	
Glendale	04-013-2001	Neighborhood	Population exposure	
Greenwood	04-013-3010	Middle	Population exposure	Closed June 2016
Higley	04-013-4006	Neighborhood	Population exposure	
Mesa	04-013-1003	Neighborhood	Population exposure	
North Phoenix	04-013-1004	Neighborhood	Population exposure	
South Phoenix	04-013-4003	Neighborhood	Population exposure	
South Scottsdale	04-013-3003	Neighborhood	Population exposure	
Tempe	04-013-4005	Neighborhood	Population exposure	
West Chandler	04-013-4004	Neighborhood	Population exposure	
West 43 <sup>rd</sup> Avenue	04-013-4009	Middle	Highest concentration	
West Phoenix	04-013-0019	Neighborhood	Population exposure	
Zuni Hills	04-013-4016	Neighborhood	Population exposure	

**Table 2.8.** PM<sub>2.5</sub> monitoring sites

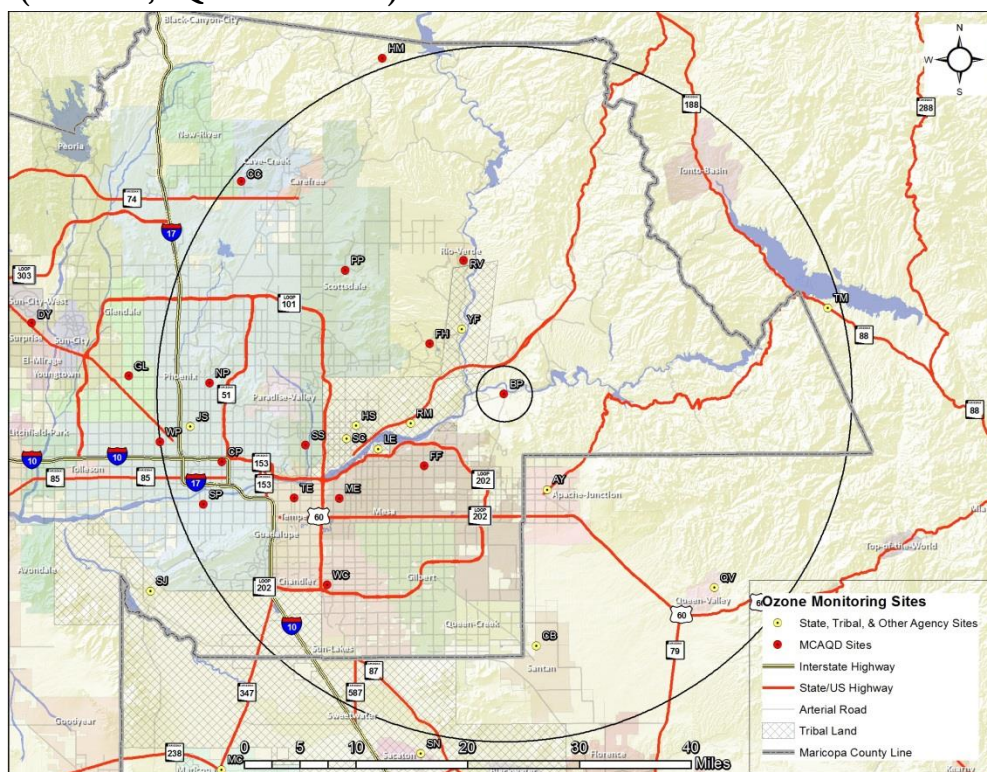
Site	AQS#	Scale	Objective	Notes
Diablo	04-013-4019	Micro scale	Source oriented	
Durango Complex	04-013-9812	Neighborhood	Highest concentration	
Glendale	04-013-2001	Neighborhood	Population exposure	
Mesa	04-013-1003	Neighborhood	Population exposure	
North Phoenix	04-013-1004	Neighborhood	Population exposure	
South Phoenix	04-013-4003	Neighborhood	Population exposure	

Tempe	04-013-4005	Neighborhood	Population exposure	
Thirty-third	04-013-4020	Micro scale	Source oriented	Opened Sep. 2015, closed March 2016, reopened Jan. 2020
West Phoenix	04-013-0019	Neighborhood	Highest concentration	

## 2.2 Summary of Sites in the MCAQD Network

The following section details each of the sites operating in the MCAQD network between 2015 and 2019. Site history, parameters monitored, and monitoring scale and objectives are detailed. A map and/or aerial photograph showing the area of the monitoring scale is also depicted.

### Blue Point (Code: BP, AQS# 04-013-9702)

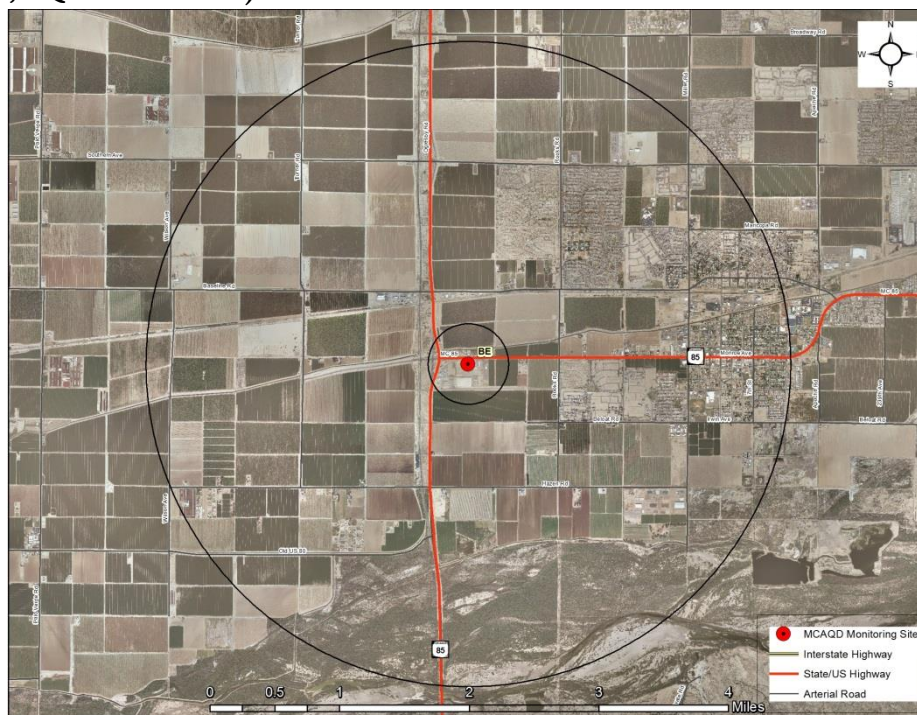


**Figure 2.2.** Map showing the location of the Blue Point monitoring site (center), including the 4 to 50 km radius of the urban monitoring scale. The map also indicates the location of O<sub>3</sub> monitors operated by other agencies, including ADEQ, Tribal, and Pinal County Air Quality (PCAQ).

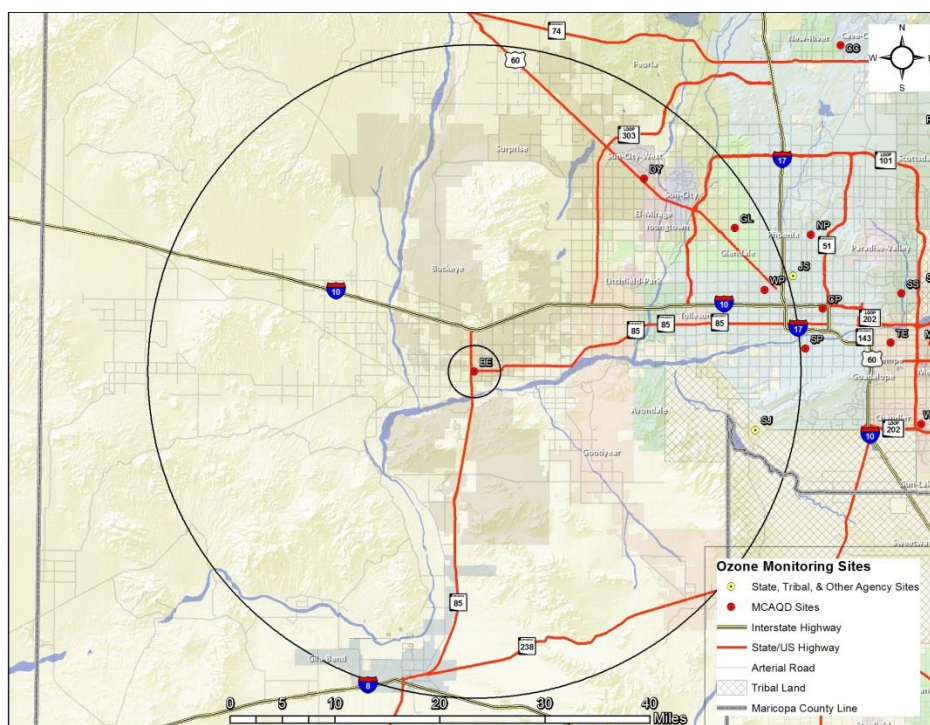
Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O <sub>3</sub>	1993	Urban (4–50 km)	Maximum ozone concentration

**Site Description:** The Blue Point site became operational in July 1995 and is located in a Maricopa County Sheriff's substation in the Tonto National Forest. This site was placed to represent the maximum O<sub>3</sub> concentration and urban-scale downwind transport conditions. The site is located approximately 64 km east of the Phoenix metropolitan area. The site monitors O<sub>3</sub>, wind speed and wind direction.

Buckeye (BE, AQS# 04-013-4011)



**Figure 2.3.** Map showing the location of the Buckeye monitoring site (center), with concentric circles representing the 0.5–4 km boundaries for the “neighborhood-scale” CO and PM<sub>10</sub> monitors.

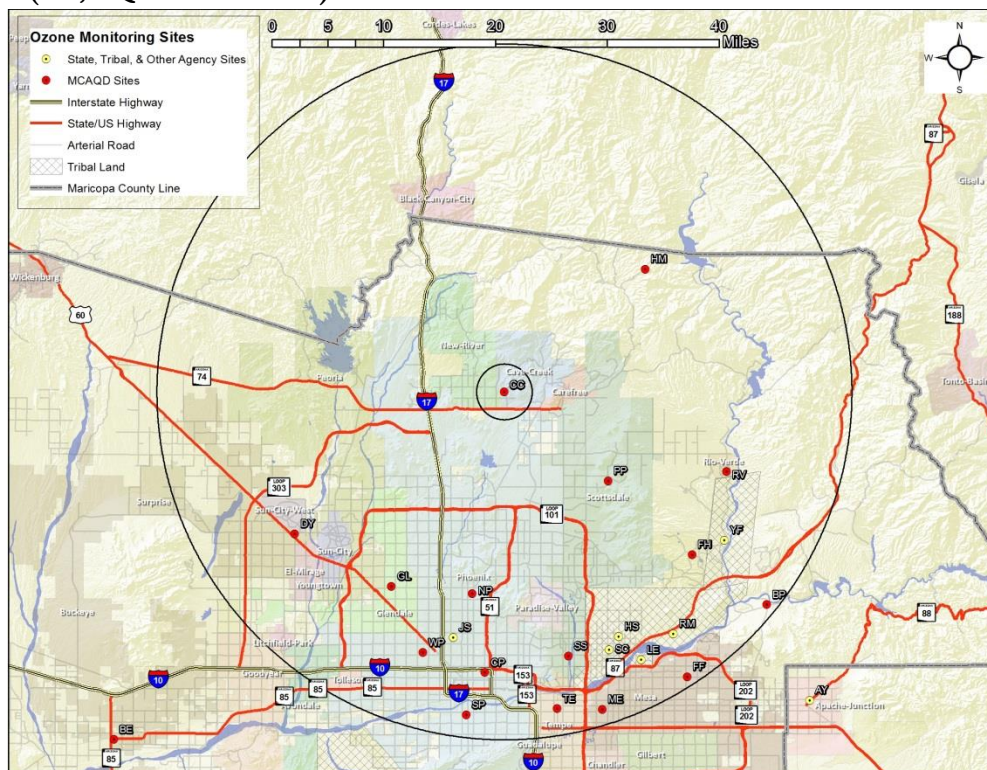


**Figure 2.4.** Map showing the location of the Buckeye monitoring site (center), with concentric circles representing the 4–50 km radius of the “urban” NO<sub>2</sub> and O<sub>3</sub> monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	2004	Neighborhood (0.5–4 km)	Upwind background
NO <sub>2</sub>	2004	Urban (4–50 km)	Upwind background
O <sub>3</sub>	2004	Urban (4–50 km)	Upwind background
PM <sub>10</sub>	2004	Neighborhood (0.5–4 km)	Population exposure

**Site Description:** The Buckeye site began operation on August 1, 2004 and monitors CO, NO<sub>2</sub>, O<sub>3</sub>, and PM<sub>10</sub> concentrations. The site is located in the Maricopa County Department of Transportation's Southwest Facility and is surrounded by agriculture and encroaching residential development. The NO<sub>2</sub> monitors at this site were originally sited with a source-oriented objective to address power plants located approximately 24 km west of the site, but after seeing little impact from the power plants this was changed to an upwind background objective to better meet monitoring conditions noted at the site. The CO and O<sub>3</sub> monitors also have upwind background objectives as they often have the lowest concentrations in the network due to a lack of significant nearby sources. Agriculture in the area is a source for PM<sub>10</sub>, so this parameter is given a population exposure objective. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

## Cave Creek (CC, AQS# 04-013-4008)

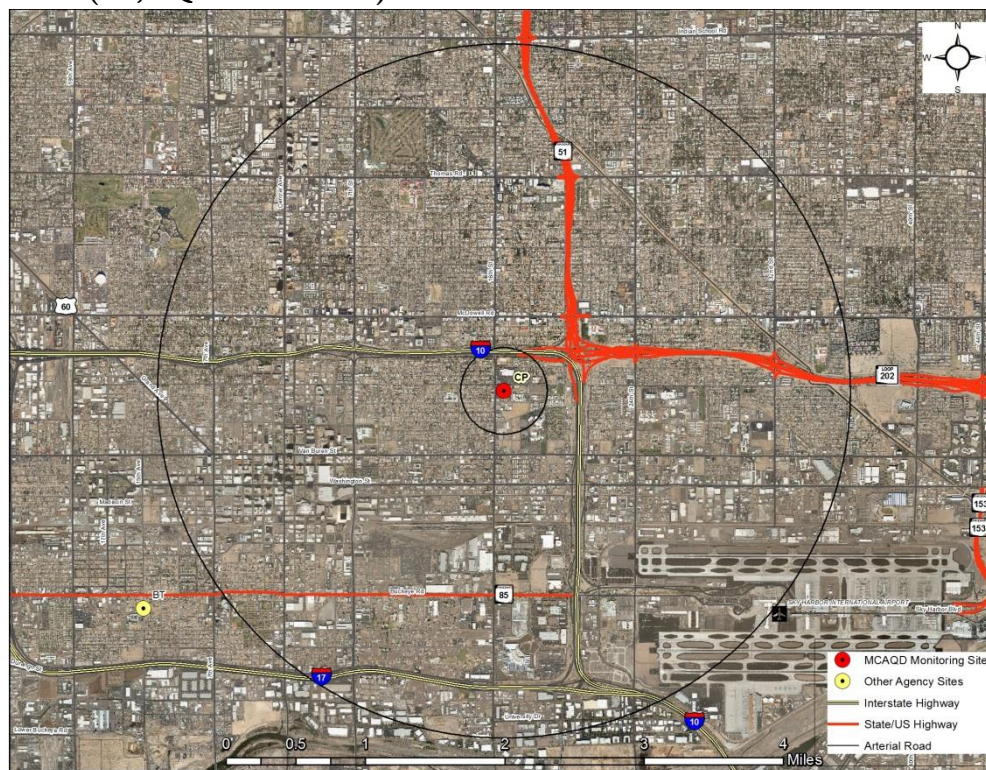


**Figure 2.5.** Map showing the location of the Cave Creek monitoring site (center), with concentric circles representing the 4–50 km radius of the “urban” monitoring scale. The map also indicates O<sub>3</sub> monitors operated by other agencies, including ADEQ, tribes, and PCAQ.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O <sub>3</sub>	2001	Urban (4–50 km)	Maximum Ozone Concentration

**Site Description:** The Cave Creek site became operational in August 2001 and is located in the Maricopa County Cave Creek Recreation Area Park Office. This site was chosen through discussions on modifying the O<sub>3</sub> network for the new (at that time) 8-hour O<sub>3</sub> standard. The site monitors O<sub>3</sub>, wind speed and wind direction.

## Central Phoenix (CP, AQS# 04-013-3002)



**Figure 2.6.** Map showing the location of the Central Phoenix monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1966	Neighborhood (0.5–4 km)	Population exposure
NO <sub>2</sub>	1967	Neighborhood (0.5–4 km)	Highest concentration
O <sub>3</sub>	1967	Neighborhood (0.5–4 km)	Population exposure
PM <sub>10</sub>	1985	Neighborhood (0.5–4 km)	Population exposure
SO <sub>2</sub>	1965	Neighborhood (0.5–4 km)	Highest concentration

**Site Description:** The Central Phoenix site has been in existence for over five decades and has provided long-term historical data with a high rate of data recovery. The site is representative of high population exposure, i.e., greater than 2000 people per square kilometer, in the central Phoenix area, and it is located close to several high-volume highways and interchanges. This site monitors for CO, NO<sub>2</sub>, O<sub>3</sub>, PM<sub>10</sub> and SO<sub>2</sub> as well as the meteorological parameters of barometric pressure, ambient temperature, and wind speed and direction.

## Deer Valley (DV, AQS# 04-013-4018)



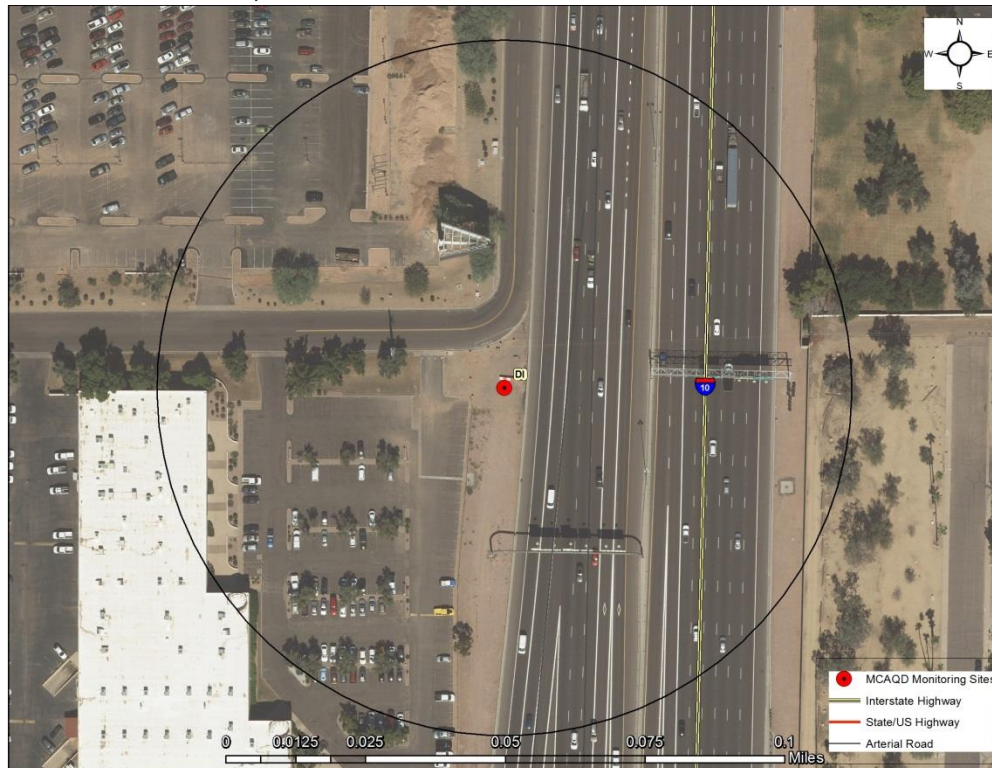
**Figure 2.7.** Map showing the location of the Deer Valley monitoring site (center), with concentric circles representing the 100–500 m radius of the “middle” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
Lead (Pb)	2010	Middle (100–500 m)	Source-oriented

**Site Description:** The Deer Valley site is located on the grounds of the Deer Valley Airport in north Phoenix. This site was started in July 2010, because changes in the Pb NAAQS necessitated that MCAQD begin Pb monitoring again. All ambient Pb monitoring had been discontinued in 1997, because Pb concentrations were consistently much lower than the air quality standard at that time. The source of Pb emissions is the general aviation fuels used in general aviation (propeller-driven aircraft), and Deer Valley Airport is one of the busiest general aviation airports in Maricopa County. In addition to Pb, this site also monitored the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

There has never been a Pb exceedance or violation at Deer Valley and ambient concentrations of Pb monitored at Deer Valley have never exceeded 20-33% of the NAAQS since monitoring commenced in 2010. In addition, calculated emissions from the adjacent Deer Valley Airport have consistently been below the 1 ton-per-year required monitoring threshold since 2014. Therefore, the EPA gave MCAQD permission to close the site at the end of December 2019.

## Diablo (DI, AQS# 04-013-4019)



**Figure 2.8.** Map showing the location of the Diablo monitoring site (center), with concentric circles representing the 100m radius of the “micro” monitoring scale.

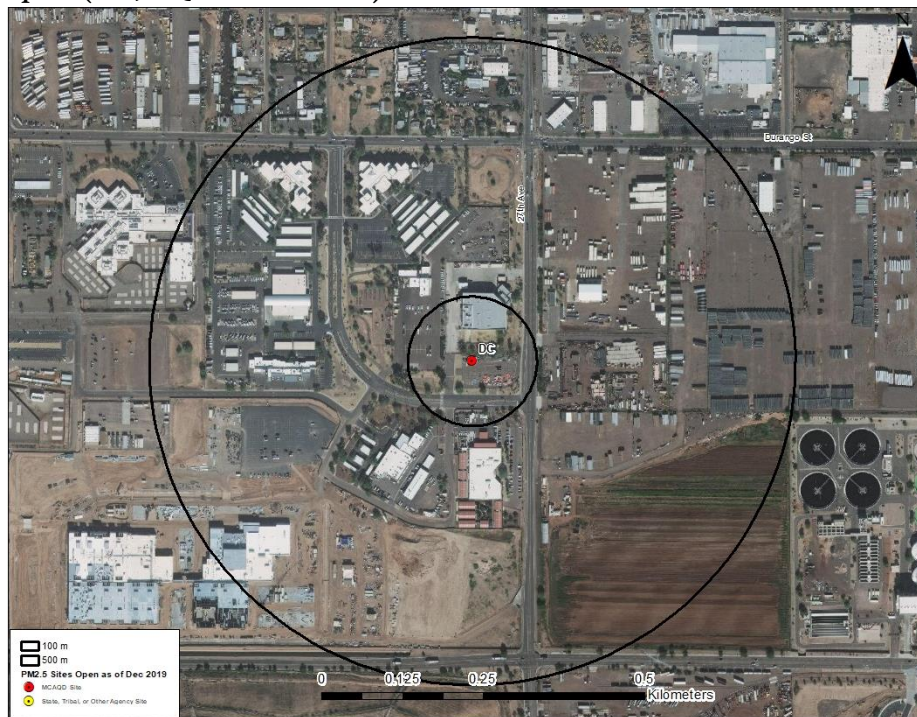
Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	2014	Micro scale (0-100 M)	Source-Oriented
NO <sub>2</sub>	2014	Micro scale (0-100 M)	Source-Oriented
PM <sub>2.5</sub>	2014	Micro scale (0-100 M)	Source-Oriented

**Site Description:** The Diablo site began operation in February 2014 as the first near-road NO<sub>2</sub> site in MCAQD’s network. This site, located near the onramp for the convergence of Interstate-10 and the US-60 highways, was chosen because it possessed many favorable elements for a near-road site. This section of highway is, on average, one of the most congested in the metropolitan area and has the highest vehicle traffic counts for light and heavy-duty vehicles. In addition, local terrain, topography, meteorology, and nearby source contribution were favorable to locating a near-road site in this area.

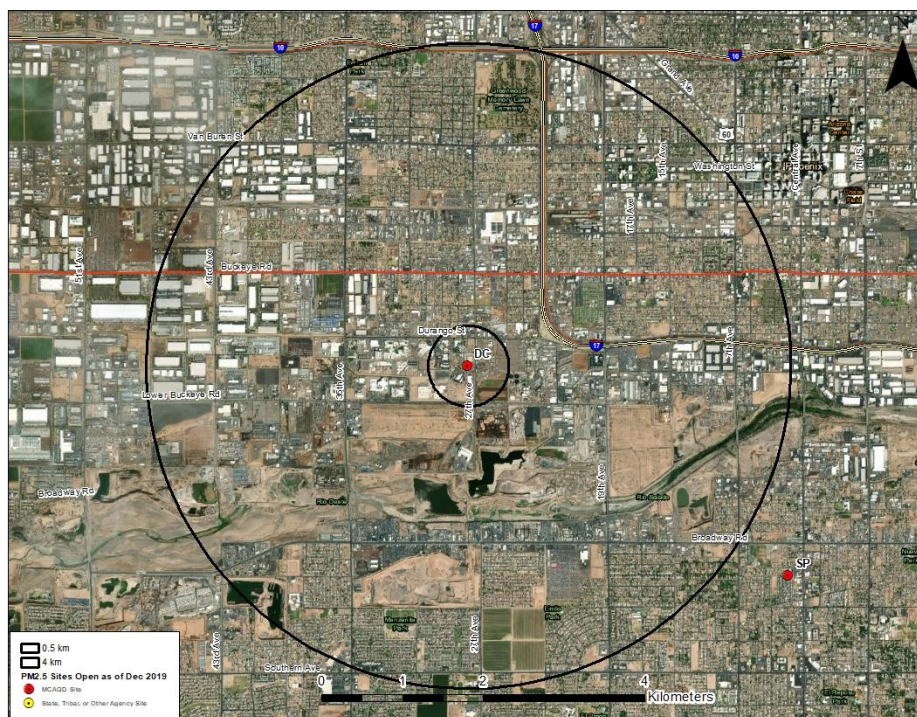
In addition to CO, NO<sub>2</sub>, and PM<sub>2.5</sub>, this site also monitors the meteorological parameters of relative humidity, ambient temperature, and wind speed and direction.

The Diablo site was permanently closed in January 2020 due to construction widening Interstate-10. A new site in the vicinity of Diablo is planned to be opened in late 2020 or early 2021.

## Durango Complex (DC, AQS# 04-013-9812)



**Figure 2.9.** Map showing the location of the Durango Complex monitoring site (center), with concentric circles representing the 100–500 m radius of the “middle” monitoring scale.



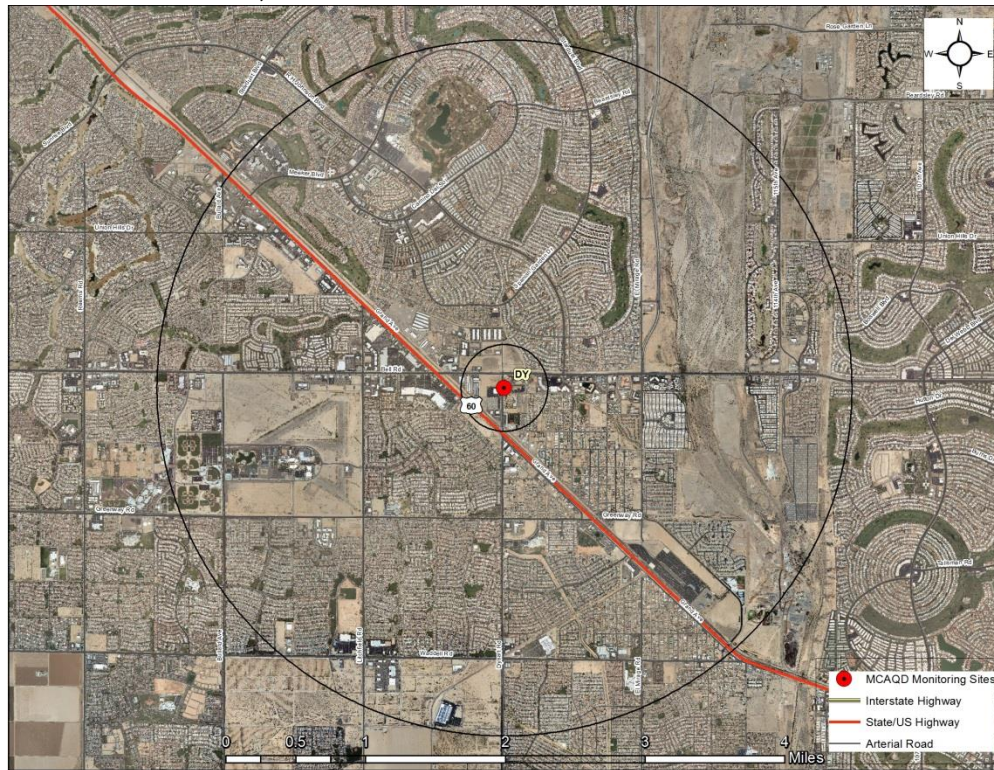
**Figure 2.10.** Map showing the location of the Durango Complex monitoring site (center), with concentric circles representing the 0.5-4.0 km radius of the “Neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
SO <sub>2</sub>	2011	Middle (100–500 m)	Highest Concentration
PM <sub>10</sub>	1999	Neighborhood (0.5–4 km)	Population exposure
PM <sub>2.5</sub>	2010	Neighborhood (0.5–4 km)	Highest concentration

**Site Description:** This site is located in the Maricopa County Flood Control District storage yard, which is 1.6 km northwest from the former Salt River site. Sampling began on January 6, 1999 with the intent to replace the former Salt River site. However, in 2000 the U.S. EPA determined that the Durango Complex site was not equivalent to the Salt River site; therefore, the West 43<sup>rd</sup> Avenue site was started and became the replacement. Continuous particulate monitors are located at this site and a SO<sub>2</sub> monitor was placed here in 2011 in response the recommendations from the 2005-2009 Network Assessment.

This site also monitors the meteorological parameters of wind speed and direction, barometric pressure, ambient temperature, and relative humidity.

**Dysart (DY, AQS# 04-013-4010)**



**Figure 2.11.** Map showing the location of the Dysart monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	2003	Neighborhood (0.5–4 km)	Population exposure
O <sub>3</sub>	2003	Neighborhood (0.5–4 km)	Population exposure
PM <sub>10</sub>	2003	Neighborhood (0.5–4 km)	Population exposure

**Site Description:** The Dysart site was established in July 2003. It is located at the Maricopa County Facility Maintenance Yard at the corner of Bell Rd. and Dysart Rd. The site is in a growing population area in the northwest valley. The land use around the site consists of subdivisions of single-family homes, commercial, and industrial properties. The site is approximately 1.6 km west of the Agua Fria riverbed. CO, O<sub>3</sub>, and PM<sub>10</sub> are monitored at this station, though the CO monitor was removed in 2016. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

## Falcon Field (FF, AQS# 04-013-1010)

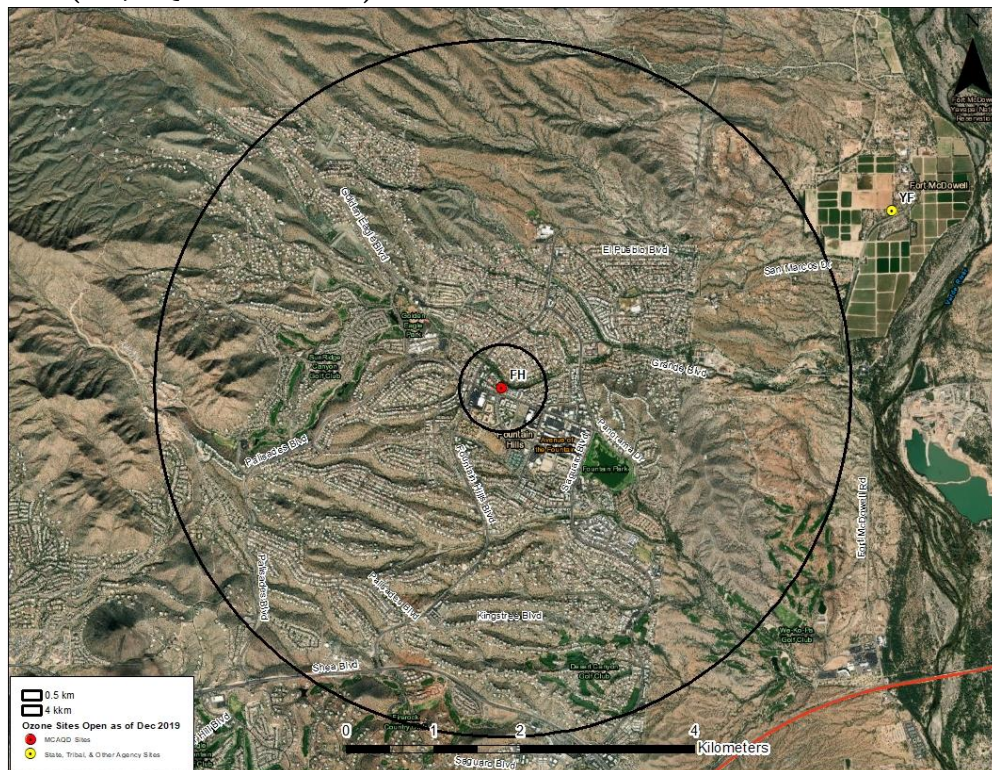


**Figure 2.12.** Map showing the location of the Falcon Field monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O <sub>3</sub>	1989	Neighborhood (0.5–4 km)	Population exposure

**Site Description:** The Falcon Field site is located within a City of Mesa fire station adjacent to the Falcon Field airport. Monitoring for O<sub>3</sub> began in 1989; since that time the surrounding area has transformed from mostly agricultural citrus fields to primarily residential development. This site also monitors the meteorological parameters of relative humidity, ambient temperature, and wind speed and direction.

## Fountain Hills (FH, AQS# 04-013-9704)

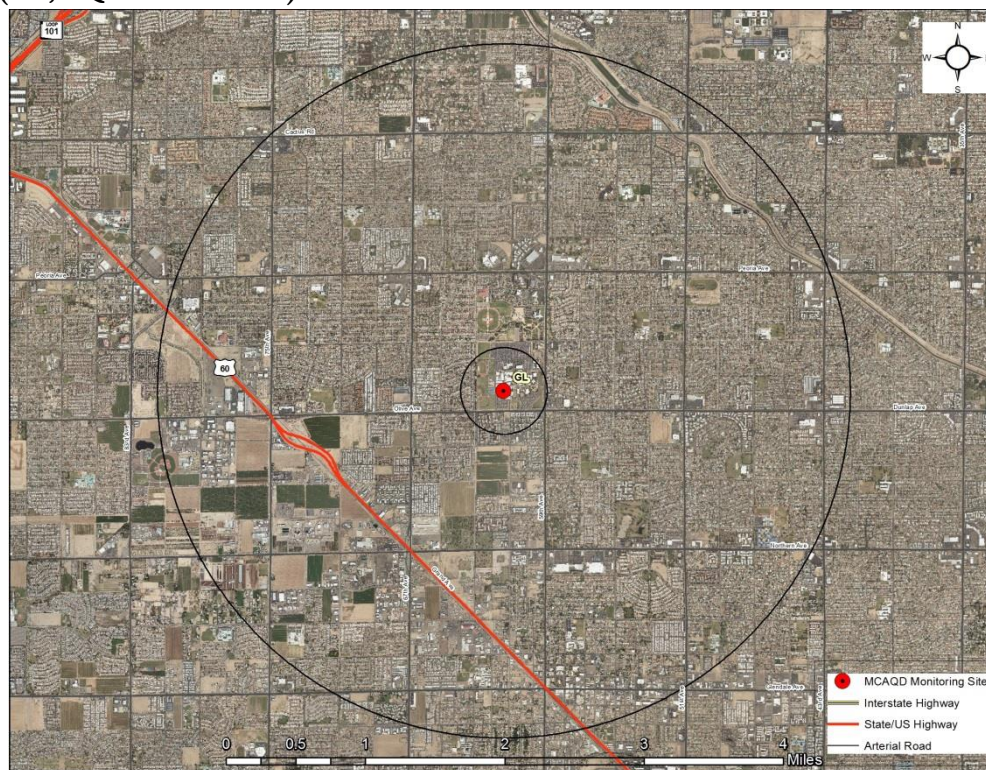


**Figure 2.13.** Map showing the location of the Fountain Hills monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O <sub>3</sub>	1996	Neighborhood (0.5–4 km)	Population exposure

**Site Description:** The site, located at a Fountain Hills fire station, became operational in April 1996 and measures O<sub>3</sub> concentrations. The site is located approximately 24 km east of the Phoenix metropolitan area, and it was chosen to represent the high downwind concentrations on the fringes of the central basin district along the predominant summer/fall daytime wind direction. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

Glendale (GL, AQS# 04-013-2001)

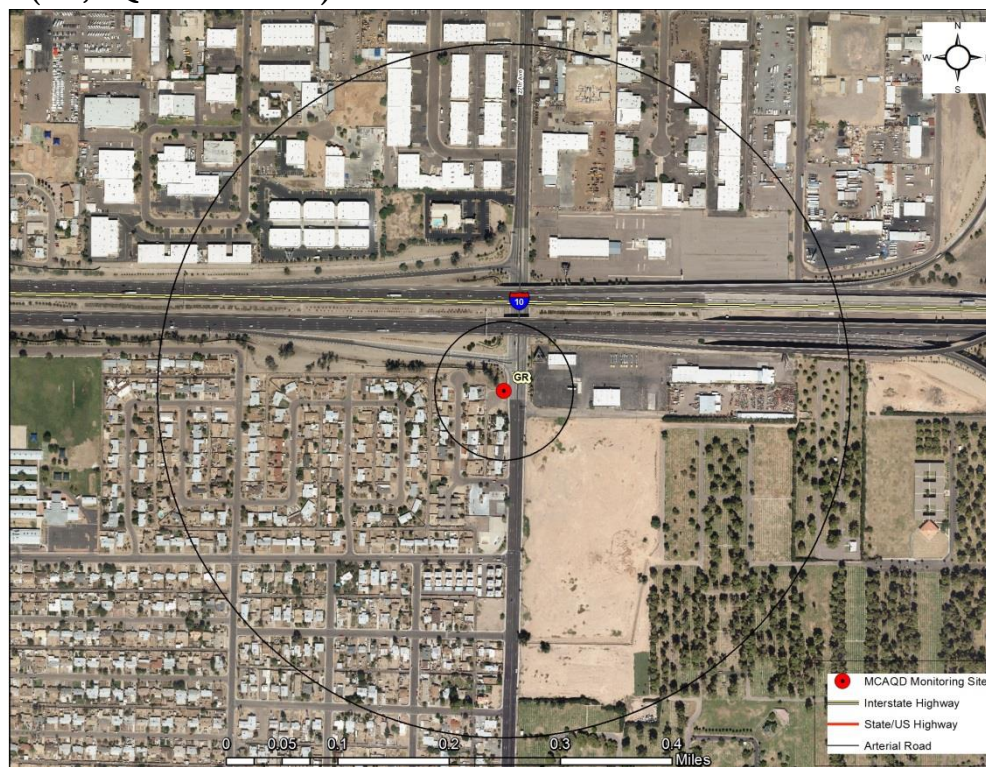


**Figure 2.14.** Map showing the location of the Glendale monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1974	Neighborhood (0.5–4 km)	Population exposure
O <sub>3</sub>	1974	Neighborhood (0.5–4 km)	Population exposure
PM <sub>10</sub>	1987	Neighborhood (0.5–4 km)	Population exposure
PM <sub>2.5</sub>	2011	Neighborhood (0.5–4 km)	Population exposure

**Site Description:** The Glendale site, established over four decades ago, is located on the grounds of Glendale Community College in a populous residential area. Single-family homes, strip malls, food establishments, and parks surround the site. CO, O<sub>3</sub>, and PM<sub>10</sub> are monitored at this station, though the CO monitor was removed in 2016. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

### Greenwood (GR, AQS# 04-013-3010)



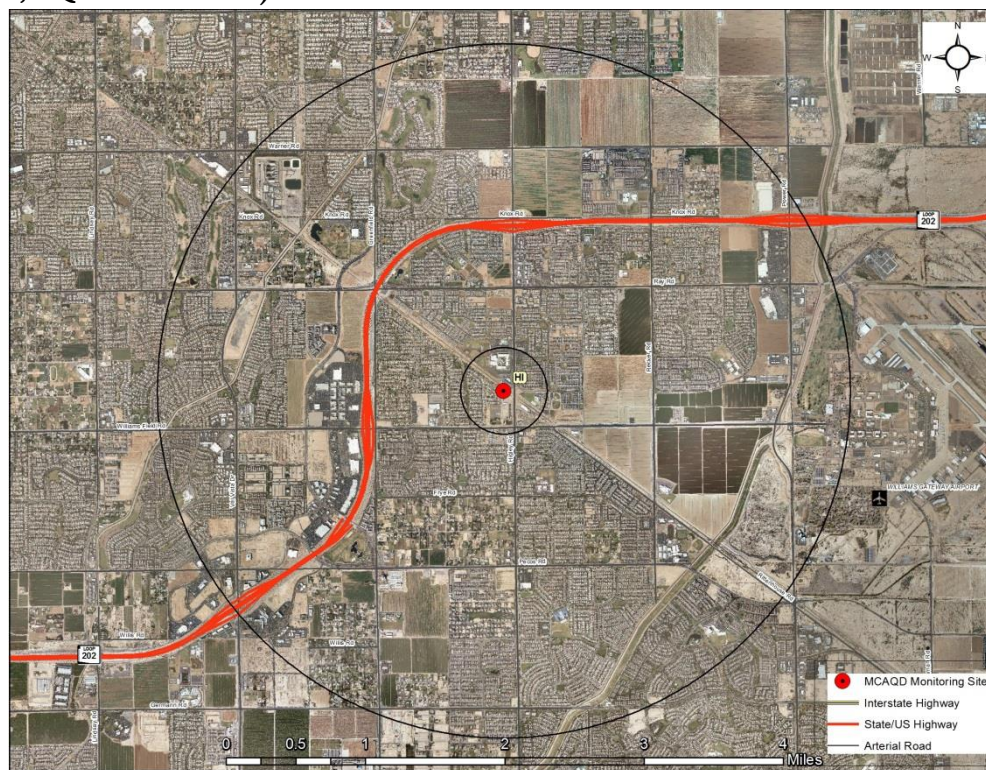
**Figure 2.15.** Map showing location of the former Greenwood monitoring site (center), including the assumed 100-500 m radius of the Middle monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1993	Middle (100–500 m)	Population exposure
NO <sub>2</sub>	1993	Middle (100–500 m)	Population exposure
PM <sub>10</sub>	1993	Middle (100–500 m)	Population exposure

**Site Description:** Monitoring began at this site in December 1993. The station was bordered on the north by Interstate 10, on the west and south by neighborhood homes, and to the east by Greenwood Cemetery. Interstate 17 is approximately 1.6 km to the east of the former site. CO, NO<sub>2</sub>, and PM<sub>10</sub> were the criteria pollutants monitored at this location. This site also monitored the meteorological parameters of barometric pressure, ambient temperature, and wind speed and direction.

This site was closed in June 2016 due to the new near-road site Thirty-Third opening approximately 1 km to the west. NO<sub>2</sub> and CO monitors are operated at the Thirty-Third site, but the PM<sub>10</sub> monitor was shut down, with EPA approval, based upon a recommendation in the 2010-2014 Network Assessment that it was redundant.

## Higley (HI, AQS# 04-013-4006)



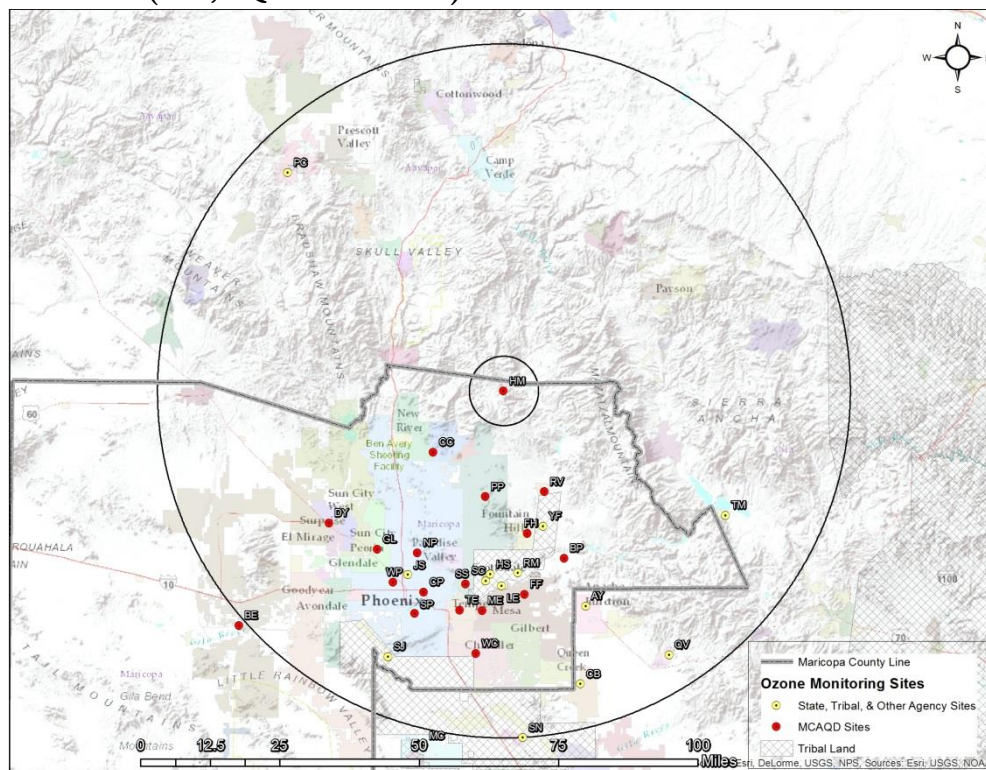
**Figure 2.16.** Map showing the location of the Higley monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
PM <sub>10</sub>	2000	Neighborhood (0.5–4 km)	Population exposure

**Site Description:** Originally, in 1994, ADEQ set up this site to monitor for background particulate concentrations near the urban limits of Maricopa County. Since then, urban expansion has enveloped the site, so it no longer serves its original intended purpose. MCAQD installed a PM<sub>10</sub> monitor in the second quarter of 2000. This monitor samples on the neighborhood scale with a monitoring objective of high population exposure. This site also monitors the meteorological parameters of barometric pressure, ambient temperature, temperature difference, and wind speed and direction.

The Roosevelt Water Conservation District, the property owner where the site was originally located, informed us to remove the monitor by the end of 2014. MCAQD shut the site down in October 2014 and constructed a new site a short distance away which opened in March 2017.

## Humboldt Mountain (HM, AQS# 04-013-9508)

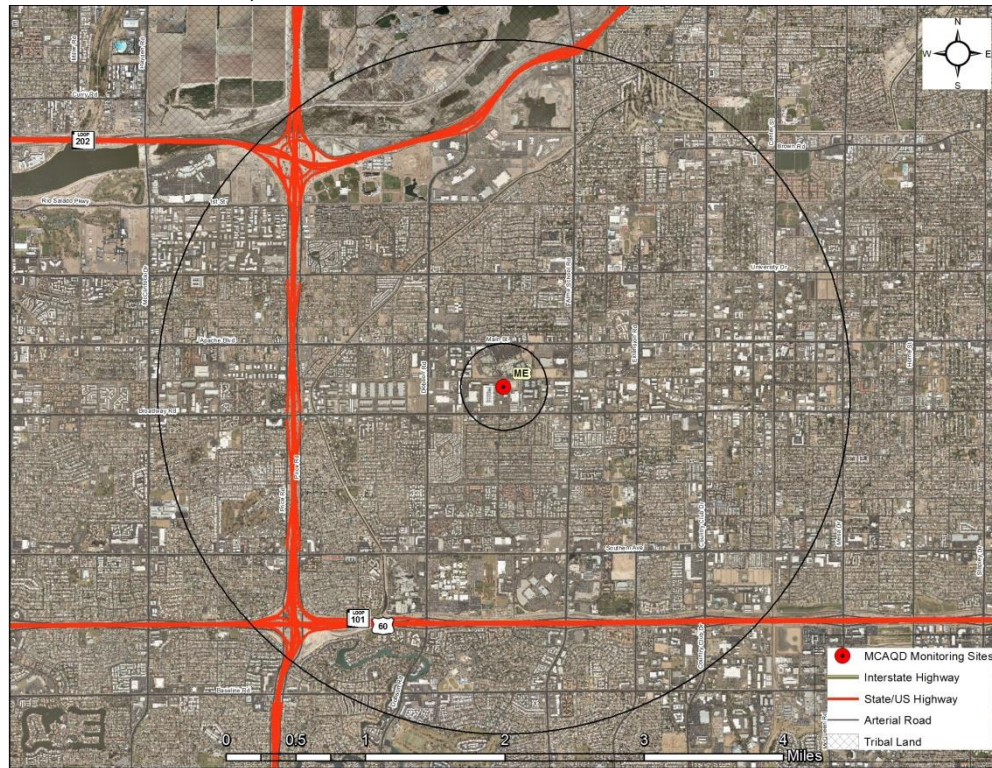


**Figure 2.17.** Map showing location of Humboldt Mountain monitoring site (center), including the assumed 10-100 km radius of the Regional monitoring scale. Map also includes O<sub>3</sub> monitors from other agencies, including ADEQ, Tribal, and PCAQ.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O <sub>3</sub>	1993	Regional (10–100+ km)	Extreme downwind

**Site Description:** This site became operational in August 1995. The Humboldt Mountain site is located on property owned by the Federal Aviation Administration, in a National Forest Service building in the Tonto National Forest. This site is located approximately 64 km north-northeast of the Phoenix metropolitan area at an elevation of 1582 m. O<sub>3</sub> is the only criteria pollutant that is monitored at this site. This site currently monitors the meteorological parameters of relative humidity, ambient temperature, and wind speed and direction.

## Mesa (ME, AQS# 04-013-1003)

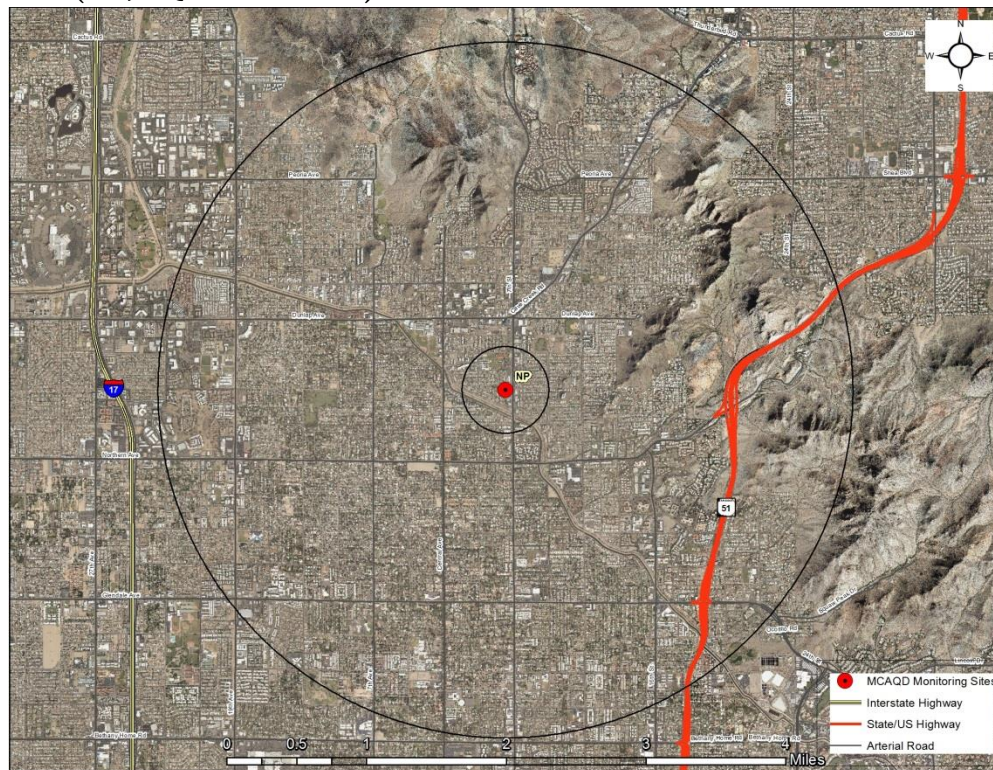


**Figure 2.18.** Map showing the location of the Mesa monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1978	Neighborhood (0.5–4 km)	Population exposure
O <sub>3</sub>	2012	Neighborhood (0.5–4 km)	Population exposure
PM <sub>10</sub>	1990	Neighborhood (0.5–4 km)	Population exposure
PM <sub>2.5</sub>	2005	Neighborhood (0.5–4 km)	Population exposure

**Site Description:** This site is located at Brooks Reservoir at the western edge of the city near the Tempe border. It is centered in an area that contains residential, commercial, and industrial activity. CO, PM<sub>10</sub>, and PM<sub>2.5</sub> are the criteria pollutants monitored at this site. The MCAQD resumed operation of the O<sub>3</sub> monitor in 2012 after a 10-year hiatus. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

## North Phoenix (NP, AQS# 04-013-1004)

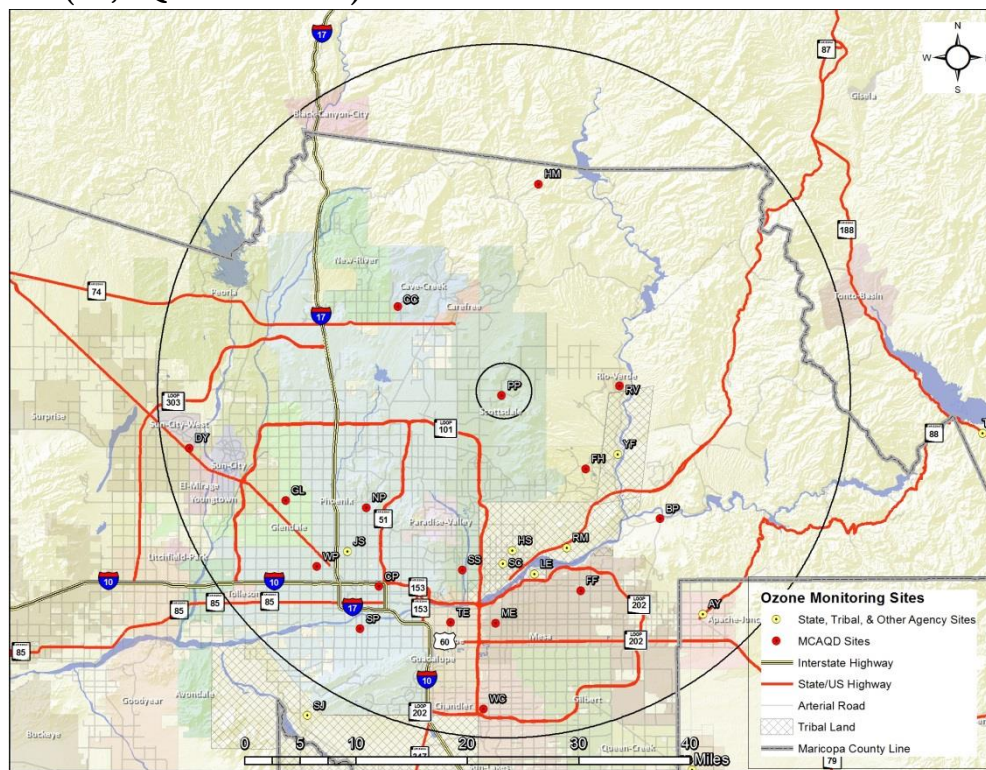


**Figure 2.19.** Map showing the location of the North Phoenix monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1974	Neighborhood (0.5–4 km)	Population exposure
O <sub>3</sub>	1975	Neighborhood (0.5–4 km)	Max ozone concentration
PM <sub>10</sub>	1990	Neighborhood (0.5–4 km)	Population exposure
PM <sub>2.5</sub>	2011	Neighborhood (0.5–4 km)	Population exposure

**Site Description:** This site is located in the Sunnyslope area of North Phoenix. Sunnyslope is an established neighborhood, primarily residential. High-density population surrounds the site. CO, O<sub>3</sub>, and PM<sub>10</sub> are monitored at this site, though the CO monitor was removed in 2016. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, wind speed and direction, and delta temperature (temperature inversion).

## Pinnacle Peak (PP, AQS# 04-013-2005)

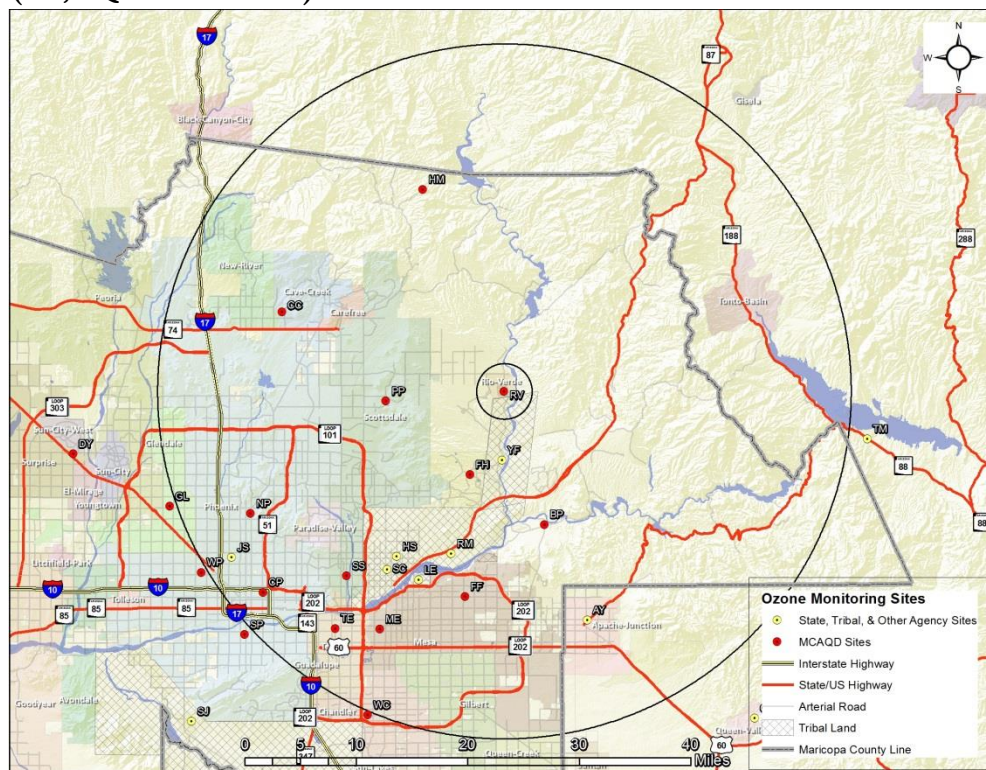


**Figure 2.20.** Map showing location of Pinnacle Peak monitoring site (center), including the assumed 4-50 km radius of the Urban monitoring scale. This map also includes O<sub>3</sub> monitors from other agencies, including ADEQ, Tribal agencies, and PCAQ.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O <sub>3</sub>	1988	Urban (4–50 km)	Maximum ozone concentration

**Site Description:** The site, originally located in 1988 on the roof of the Troon Golf Course Country Club in North Scottsdale, was moved a kilometer south in 2012 to their maintenance yard. This was at the request by the property owner. It is located in a geographic area of low-density population (less than 1000 people per square kilometer). In the current and previous years, O<sub>3</sub> exceedances have been recorded due to transport of O<sub>3</sub> and precursors from more urbanized areas of metropolitan Phoenix. In addition to O<sub>3</sub>, this site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

**Rio Verde (RV, AQS# 04-013-9706)**



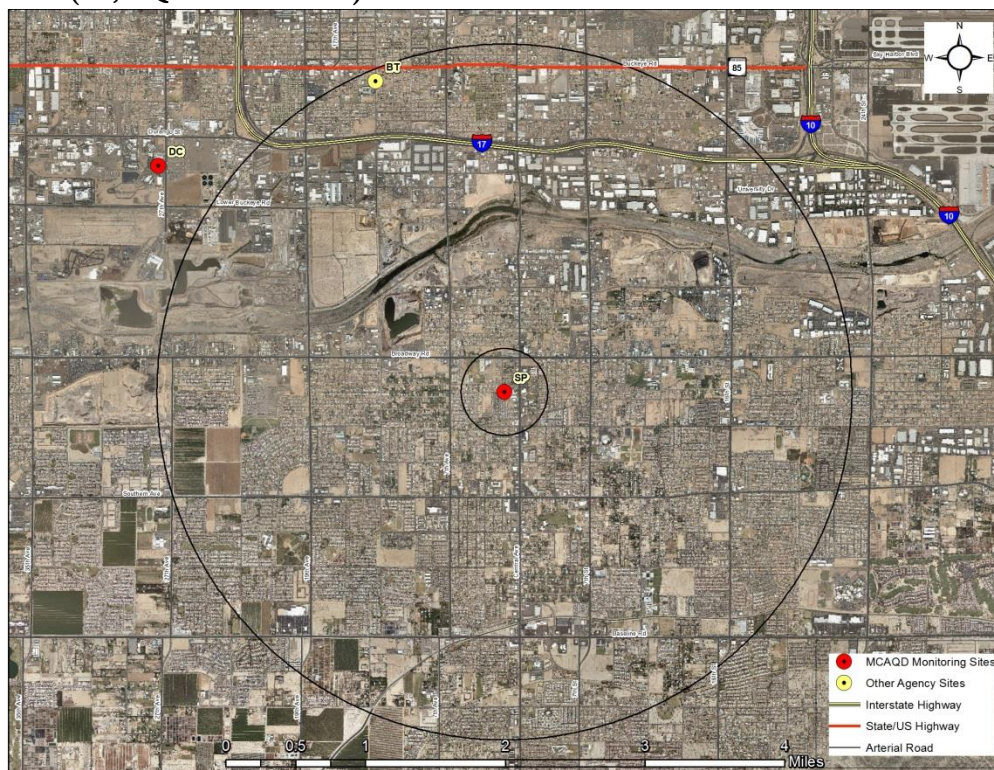
**Figure 2.21.** Map showing location of the former Rio Verde monitoring site (center), including the 4–50 km radius of the urban monitoring scale. The map also indicates O<sub>3</sub> monitors operated by other agencies, including ADEQ, Tribal agencies, and PCAQ.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
O <sub>3</sub>	1997	Urban (4–50 kilometers)	Maximum Ozone Concentration

**Site Description:** This O<sub>3</sub> site became operational in spring 1997. The monitor was located at the fire station and County Sheriff's office sub-station located in a residential area surrounded by the desert of Tonto National Forest. The site was 13 km north of the Fountain Hills station, on the edge of a Class I Wilderness Area. O<sub>3</sub> was the only parameter monitored at this site.

Based upon the analyses in the 2010-2014 Network Assessment, this site was closed, with EPA approval, in October 2017. The 2010-2014 analyses found the O<sub>3</sub> monitor to be redundant with several other nearby monitors. In addition, construction at the Rio Verde site in 2012 added more structures to the area, including an additional story to the fire station building where the monitor is housed. Coincidental with these structural changes, O<sub>3</sub> concentrations at the monitor decreased in comparison with O<sub>3</sub> concentrations at other nearby sites and the past history of O<sub>3</sub> concentrations in the area. These changes drove MCAQD to conclude that the Rio Verde monitor was no longer representative of ambient O<sub>3</sub> in this area of Maricopa County.

### South Phoenix (SP, AQS# 04-013-4003)



**Figure 2.22.** Map showing the location of the South Phoenix monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established		Scale	Objective(s)
	Original Site	Current Site		
CO	1974	1999	Neighborhood (0.5–4 km)	Population exposure
O <sub>3</sub>	1975	1999	Neighborhood (0.5–4 km)	Population exposure
PM <sub>10</sub>	1985	1999	Neighborhood (0.5–4 km)	Population exposure
PM <sub>2.5</sub>	—	2005	Neighborhood (0.5–4 km)	Population exposure

**Site Description:** The site was originally opened in 1974 under AQS# 04-013-0013 but was moved a short distance to its current location in October 1999 and changed to AQS# 04-013-4003. The site borders on a mixture of residential and commercial (retail stores, food establishments, and office parks) land use. The site is situated near two densely populated areas (>2000 people per square kilometer) north and west of the site. CO, O<sub>3</sub>, PM<sub>10</sub>, and PM<sub>2.5</sub> are monitored at this station. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

### South Scottsdale (SS, AQS# 04-013-3003)



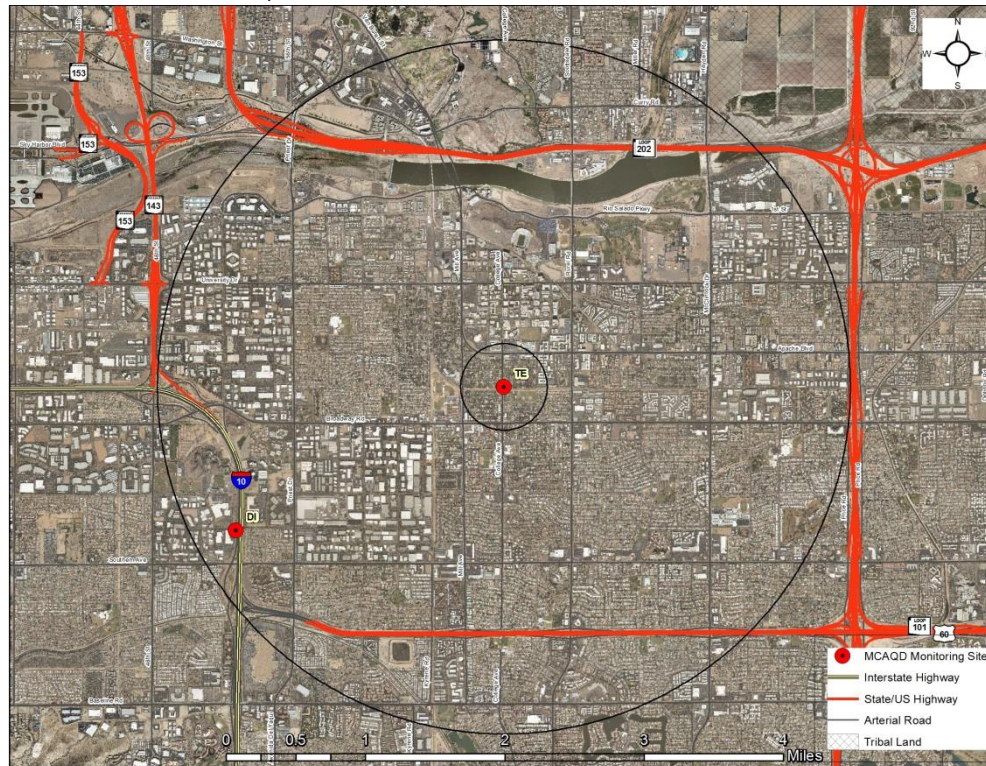
**Figure 2.23.** Map showing the location of the South Scottsdale monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “Neighborhood”- scale CO, O<sub>3</sub>, PM<sub>10</sub>, and SO<sub>2</sub> monitors.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1974	Neighborhood (0.5–4 km)	Population exposure
O <sub>3</sub>	1974	Neighborhood (0.5–4 km)	Population exposure
PM <sub>10</sub>	1987	Neighborhood (0.5–4 km)	Population exposure

**Site Description:** This long-term site is located at a City of Scottsdale Fire Station. The area surrounding the site is residential with a density of 1,000 to 2,000 persons per square kilometer. This site is located 19 km east of metropolitan Central Phoenix. CO, NO<sub>2</sub>, O<sub>3</sub>, PM<sub>10</sub>, and SO<sub>2</sub> were all previously monitored at this station; however, the 2005-2009 Network Assessment found that the SO<sub>2</sub> and NO<sub>2</sub> monitors were ineffective and recommended moving them. In December 2010, the SO<sub>2</sub> monitor at South Scottsdale was moved west to the Durango Complex site. The NO<sub>2</sub> monitor was then closed in June 2011. The 2010-2014 Network Assessment found that the CO monitor was redundant and it was removed in 2016, leaving only the O<sub>3</sub> and PM<sub>10</sub> monitors operating at the end of 2019.

This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

# Tempe (TE, AQS# 04-013-4005)



**Figure 2.24.** Map showing the location of the Tempe monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	2000	Neighborhood (0.5–4 km)	Population exposure
O <sub>3</sub>	2000	Neighborhood (0.5–4 km)	Population exposure
PM <sub>10</sub>	2012	Neighborhood (0.5–4 km)	Population exposure
PM <sub>2.5</sub>	2012	Neighborhood (0.5–4 km)	Population exposure

**Site Description:** The site was established in 2000 to fill in a spatial gap between the metropolitan Phoenix area and the city of Mesa. O<sub>3</sub> and CO have been monitored at this site since it opened, and PM<sub>10</sub> and PM<sub>2.5</sub> monitors were added in 2012 in response to recommendation from the 2005-2009 Network Assessment. The 2010-2014 Network Assessment found the CO monitor to be redundant and it was removed in 2016. Wind speed and direction, rainfall, ambient temperature, and delta temperature (temperature inversion) meteorological parameters are also monitored at this site. The station is located just south of the Arizona State University campus and is surrounded by residential and commercial properties.

### Thirty-third (TT, AQS# 04-013-4020)



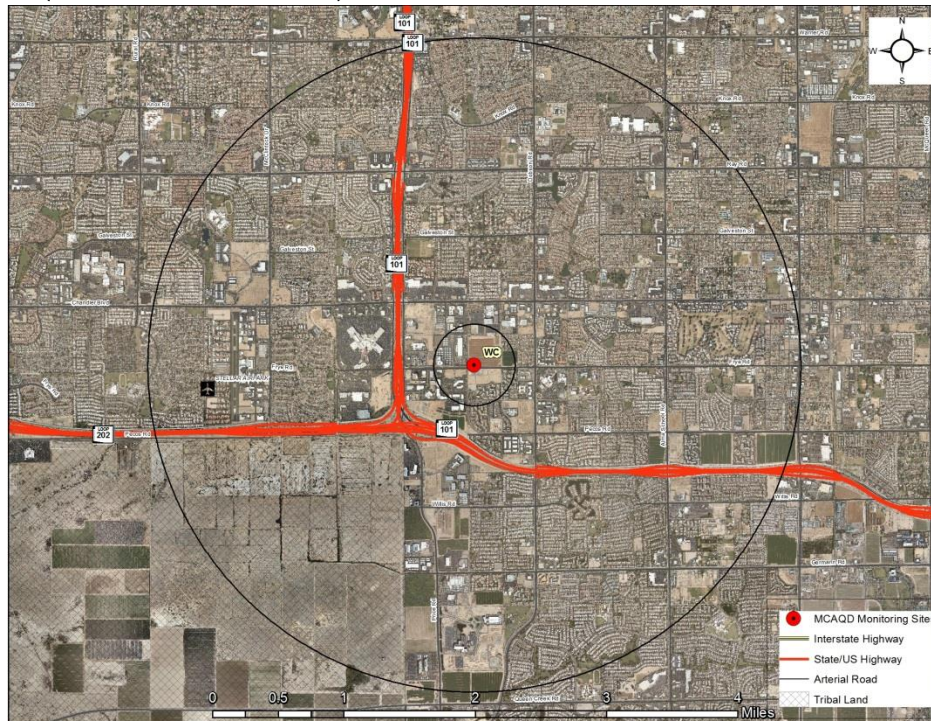
**Figure 2.25.** Map showing the location of the Thirty-third monitoring site (center), with concentric circles representing the 100m radius of the “micro” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	2015	Micro scale (0-100 M)	Source-Oriented
NO <sub>2</sub>	2015	Micro scale (0-100 M)	Source-Oriented
PM <sub>2.5</sub>	2015	Micro scale (0-100 M)	Source-Oriented

**Site Description:** The Thirty-third site began operation in September 2015 as the second near-road NO<sub>2</sub> site in MCAQD’s network. This site, located near the 35<sup>th</sup> Avenue onramp to the Interstate-10, was chosen because it possessed many favorable elements for a near-road site. As a major commuter route, this section of highway is one of the most congested in the western metropolitan area and has high daily vehicle counts. In addition, local terrain, topography, meteorology, and nearby source contribution were favorable to locating a near-road site in this area. However, the Diablo near-road site has the greater traffic volumes and since only one CO and PM<sub>2.5</sub> near-road monitor is required in the network, the Thirty-Third CO and PM<sub>2.5</sub> monitors were removed in 2016 in favor of the Diablo monitors. Road construction shut the Diablo monitor down in January 2020 so the Diablo CO and PM<sub>2.5</sub> monitors were moved back to Thirty-Third, though it likely that they will be moved back to the Diablo replacement site.

In addition to CO, NO<sub>2</sub>, and PM<sub>2.5</sub>, this site also monitors the meteorological parameters of relative humidity, ambient temperature, and wind speed and direction.

## West Chandler (WC, AQS# 04-013-4004)



**Figure 2.26.** Map showing the location of the West Chandler monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood”-scale CO, O<sub>3</sub>, and PM<sub>10</sub> monitors.

Pollutant(s) Monitored	Year Established		Scale	Objective(s)
	Original Site	Current Site		
CO	1993	2000	Neighborhood (0.5–4 km)	Population exposure
O <sub>3</sub>	1993	2000	Neighborhood (0.5–4 km)	Population exposure
PM <sub>10</sub>	1993	2000	Neighborhood (0.5–4 km)	Population exposure

**Site Description:** This site was first established in January 1993 under AQS #04-013-3009. The site was moved one kilometer to the southeast in May 2000 and changed to AQS #04-013-4004. A wide range of land uses surround the site including residential, agriculture, and heavy industry such as semiconductor manufacturing plants and liquid air storage. CO, O<sub>3</sub>, and PM<sub>10</sub> are the criteria pollutants monitored at this site. This site also monitors the meteorological parameters of barometric pressure, relative humidity, ambient temperature, and wind speed and direction.

## West 43rd Avenue (WF, AQS# 04-013-4009)



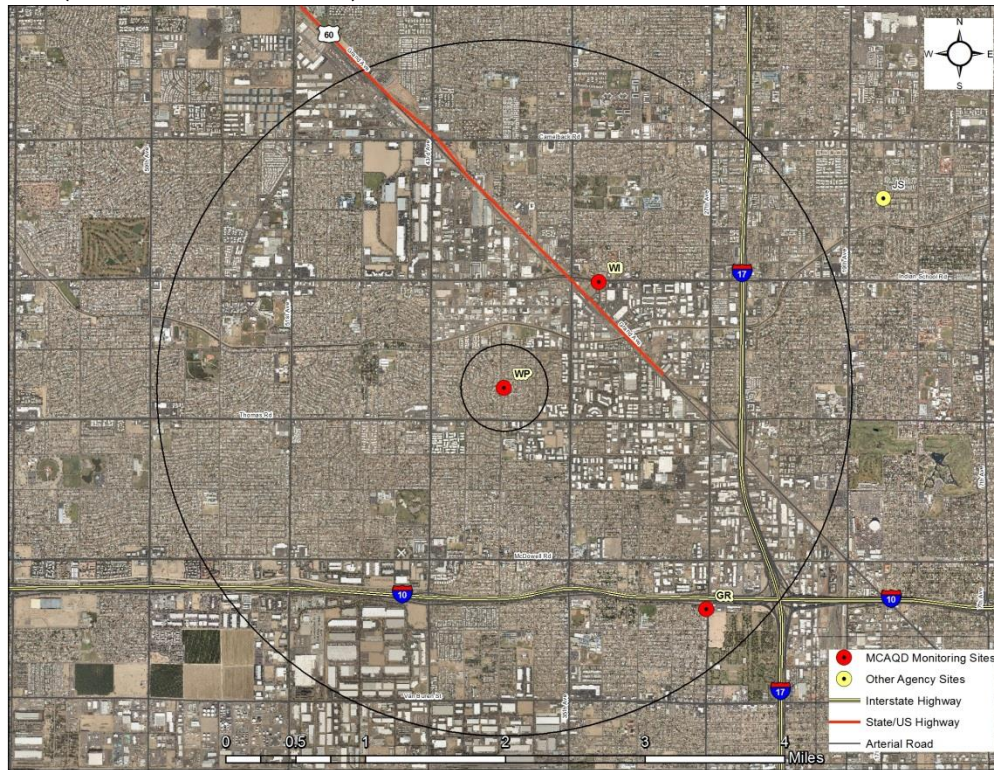
**Figure 2.27.** Map showing the location of the West 43rd Ave. monitoring site (center), with concentric circles representing the 100–500 m radius of the “middle” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
PM <sub>10</sub>	2002	Middle (100–500 m)	Highest concentration

**Site Description:** This site started as a replacement for the Salt River site (AQS #04-013-3007), located approximately 3 km to the northeast and closed in 2000, after it was determined that the Durango Complex site was not an adequate replacement. Monitoring began at the site in the second quarter of 2002. This site is located at a Maricopa County Department of Transportation storage lot and is surrounded by a combination of heavy industry and residential homes. The main purposes of the site are to measure maximum concentration PM<sub>10</sub> and to determine the impact on ambient pollution levels of significant sources or source categories. The sources around the site include sand and gravel operations, automotive and metal recycling facilities, landfills, paved and unpaved haul roads, and cement casting operations.

This site also monitors the meteorological parameters of barometric pressure, ambient temperature, temperature difference (temperature inversion), and wind speed and direction.

## West Phoenix (WP, AQS# 04-013-0019)

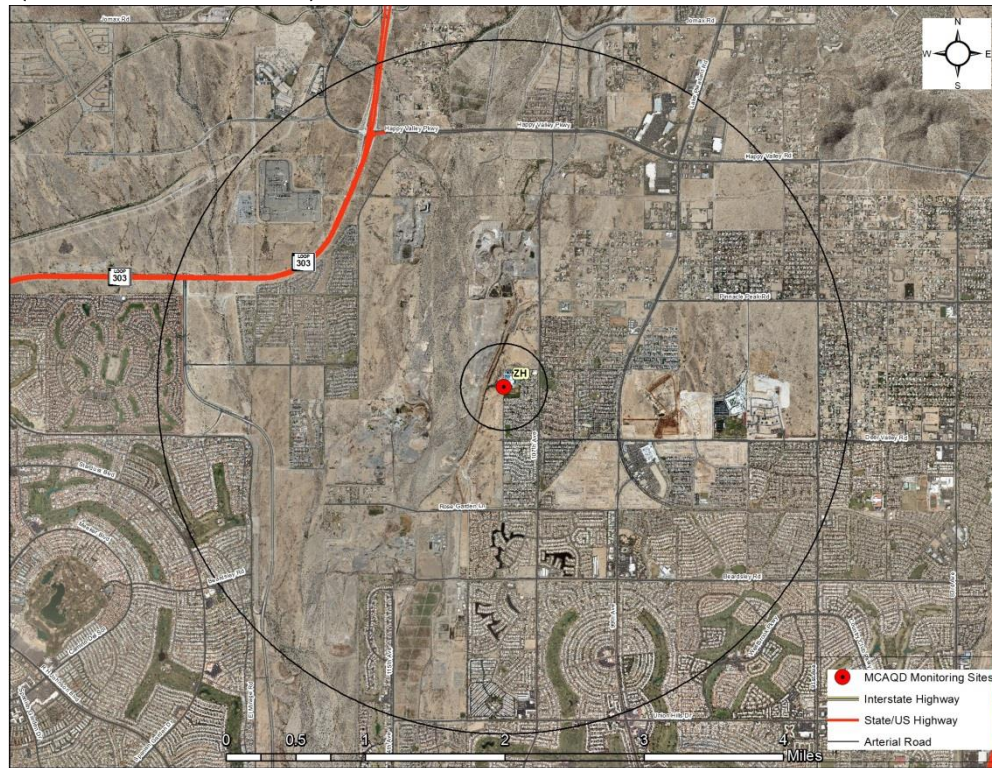


**Figure 2.28.** Map showing the location of the West Phoenix monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
CO	1984	Neighborhood (0.5–4 km)	Highest concentration
NO <sub>2</sub>	1990	Neighborhood (0.5–4 km)	Population exposure
O <sub>3</sub>	1984	Neighborhood (0.5–4 km)	Population exposure
PM <sub>10</sub>	1988	Neighborhood (0.5–4 km)	Population exposure
PM <sub>2.5</sub>	2000	Neighborhood (0.5–4 km)	Highest concentration

**Site Description:** This site, which is located in a City of Phoenix groundwater well enclosure, became operational in 1984. It is located in an area consisting mostly of stable, high-density residential parcels, though there are some nearby commercial and industrial areas. CO, NO<sub>2</sub>, O<sub>3</sub>, PM<sub>10</sub>, and PM<sub>2.5</sub> are monitored at this site. This site also monitors the meteorological parameters of barometric pressure, ambient temperature, temperature difference (temperature inversion), and wind speed and direction.

## Zuni Hills (ZH, AQS# 04-013-4016)



**Figure 2.29.** Map showing the location of the Zuni Hills monitoring site (center), with concentric circles representing the 0.5–4 km radius of the “neighborhood” monitoring scale.

Pollutant(s) Monitored	Year Established	Scale	Objective(s)
PM <sub>10</sub>	2009	Neighborhood (0.5–4 km)	Population exposure

**Site Description:** This site was opened in December 2009 as a replacement for the now-closed Coyote Lakes site (AQS #04-013-4014) and is located on the campus of the Zuni Hills elementary school, which is approximately 2.7 km to the northeast from the old Coyote Lakes monitor. The Coyote Lakes monitor was a special purpose middle-scale PM<sub>10</sub> monitor with a source-oriented objective; the sources being sand & gravel mining operations in the area of the Agua Fria riverbed. The Zuni Hills site, in contrast, has an objective of measuring air quality in an area of higher population density and at a scale of neighborhood dimensions. In addition to PM<sub>10</sub>, this site also monitors the meteorological parameters of ambient temperature and wind speed and direction.

### Section 3: Monitor-to-Monitor Comparisons

In this section the existing MCAQD monitoring network is assessed, and monitor-to-monitor comparisons are conducted using a series of indicators and analyses. These comparisons rank each air quality monitor against each other to determine its comparative value. Finally, each indicator is assigned a weight and the monitoring network is ranked by the weighted averages. These rankings are then used for subsequent analyses, including comparing the value of a monitor to specific criteria, evaluating a monitor's objective, and identifying monitors of lesser utility that can potentially be terminated. Indicators are chosen to represent pertinent topics, e.g. economic cost-effectiveness, correlation and redundancies, proximity to population and sources, suitability for pollution modeling, and actual pollutant concentrations monitored. The objective of having these different, often competing, indicators is to provide a comprehensive evaluation technique; weighting factors are used to emphasize particularly important indicators. Table 3.0.1 below lists the indicators used; this list includes several indicators that were adapted from an EPA guidance document<sup>1</sup> as well as those developed independently by the author (the Predicted Ozone, Traffic Counts, and Environmental Justice—Minority Population Served Indicators).

**Table 3.0.1.** List of indicators used in Section 3 of this assessment.

#	Indicator
1	Number of Parameters Monitored
2	Trends Impact
3	Measured Concentrations
4	Deviation from the NAAQS
5	Area Served
6	Population Served
7	Monitor-to-Monitor Correlation
8	Removal Bias
9a	Emissions Inventory
9b (for O <sub>3</sub> only)	Predicted Ozone
10	Traffic Counts
11	Environmental Justice-Minority Population Served

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1 Raffuse, S. M., Sullivan, D. C., McCarthy, M. C., Penfold, B. M. & Hafner, H. R. (2007) Ambient Air Monitoring Network Assessment Guidance: Analytical Techniques for Technical Assessments of Ambient Air Monitoring Networks. U.S. Environmental Protection Agency, Research Triangle Park, NC.

### 3.1 Analysis #1: Number of Parameters Monitored

The first analysis to be performed is a simple measure of the number of parameters that are monitored at each site. This analysis counts parameters that MCAQD enters into AQS, i.e. criteria pollutant concentrations, wind speed, wind direction and temperature difference. It does not include ancillary parameters, e.g. pressure, temperature, or PM volatiles on the PM<sub>2.5</sub> monitors, since these are dependent on the parent parameter. Sites with the most parameters monitored are ranked highest; sites with the same number of parameters monitored are ranked equally.

While criteria pollutants are the primary focus of this analysis, wind speed and direction, and temperature difference parameters are also included because these data are valuable in modeling exercises, and thus are entered into the AQS database. Note that many of these sites also record other meteorological parameters such as temperature, barometric pressure, and relative humidity, but these have not been included in this analysis.

The value from this analysis derives from the benefits of having multiple parameters measured at the same site. First, collocated measurements of several pollutants can be used in model evaluation, source apportionment, and emission inventory reconciliation. Second, a single site with multiple pollutants measured is more cost-effective than having multiple single pollutant sites.

This single analysis naturally applies to all pollutant parameters, i.e., CO, O<sub>3</sub>, NO<sub>2</sub>, particulates (both PM<sub>10</sub> and PM<sub>2.5</sub>), and SO<sub>2</sub>, and will be weighed against all of them in the final evaluation. A disadvantage of this analysis is that it does not differentiate between different pollutant types and the relative importance of each; e.g. it gives the same weight to PM<sub>10</sub> as SO<sub>2</sub>, although PM<sub>10</sub> is of much more concern within Maricopa County.

Note that this analysis is the primary method of judging a site's economic value.

### 3.1.1 Results for All Parameters

**Table 3.1.1.** All MCAQD CO monitoring sites, ranked by number of parameters monitored.

Maricopa County AQD Site	AQS Identifier	Acronym	Total Number of Parameters Monitored	Score
West Phoenix	04-013-0019	WP	7	4
Central Phoenix	04-013-3002	CP	6	3
Buckeye	04-013-4011	BE	5	2
Mesa	04-013-1003	ME	5	2
South Phoenix	04-013-4003	SP	5	2
West Chandler	04-013-4004	WC	4	1
Diablo	04-013-4019	DI	4	1
Dysart	04-013-4010	DY	Site closed Mar 2016	-
Glendale	04-013-2001	GL	Site closed Mar 2016	-
Greenwood	04-013-3010	GR	Site closed Jun 2016	-
North Phoenix	04-013-1004	NP	Site closed Mar 2016	-
South Scottsdale	04-013-3002	SS	Site closed Mar 2016	-
Tempe	04-013-4005	TE	Site closed Mar 2016	-
Thirty-third	04-013-4020	TT	*	-

\*Not included in analysis due to limited operating time

**Table 3.1.2.** All MCAQD NO<sub>2</sub> monitoring sites, ranked by number of parameters monitored.

Maricopa County AQD Site	AQS Identifier	Acronym	Total Number of Parameters Monitored	Score
West Phoenix	04-013-0019	WP	7	4
Central Phoenix	04-013-3002	CP	6	3
Buckeye	04-013-4011	BE	5	2
Thirty-third	04-013-4020	TT	4	1
Diablo	04-013-4019	DI	4	1
Greenwood	04-013-3010	GR	Site closed Jun 2016	-

**Table 3.1.3.** All MCAQD O<sub>3</sub> monitoring sites, ranked by number of parameters monitored.

Maricopa County AQD Site	AQS Identifier	Acronym	Total Number of Parameters Monitored	Score
West Phoenix	04-013-0019	WP	7	6
Central Phoenix	04-013-3002	CP	6	5
North Phoenix	04-013-1004	NP	5	4
Tempe	04-013-4005	TE	5	4
South Phoenix	04-013-4003	SP	5	4
Buckeye	04-013-4011	BE	5	4
Mesa	04-013-1003	ME	5	4
Glendale	04-013-2001	GL	4	3
West Chandler	04-013-4004	WC	4	3
Dysart	04-013-4010	DY	3	2
South Scottsdale	04-013-3003	SS	3	2
Pinnacle Peak	04-013-2005	PP	2	1
Falcon Field	04-013-1010	FF	2	1
Blue Point	04-013-9702	BP	2	1
Fountain Hills	04-013-9704	FH	2	1
Cave Creek	04-013-4008	CC	2	1
Humboldt Mountain	04-013-9508	HM	2	1
Rio Verde	04-013-9706	RV	Site closed Oct 2017	-

**Table 3.1.4.** All MCAQD PM<sub>10</sub> monitoring sites, ranked by number of parameters monitored.

Maricopa County AQD Site	AQS Identifier	Acronym	Total Number of Parameters Monitored	Score
West Phoenix	04-013-0019	WP	7	6
Central Phoenix	04-013-3002	CP	6	5
Buckeye	04-013-4011	BE	5	4
Mesa	04-013-1003	ME	5	4
North Phoenix	04-013-1004	NP	5	4
South Phoenix	04-013-4003	SP	5	4
Tempe	04-013-4005	TE	5	4
Glendale	04-013-2001	GL	4	3
Durango Complex	04-013-9812	DC	4	3
West Chandler	04-013-4004	WC	4	3
Dysart	04-013-4010	DY	3	2
Higley	04-013-4006	HI	3	2
South Scottsdale	04-013-3003	SS	3	2
West 43 <sup>rd</sup> Avenue	04-013-4009	WF	3	2
Zuni Hills	04-013-4016	ZH	2	1
Greenwood	04-013-3010	GR	Site closed Jun 2016	-

**Table 3.1.5.** All MCAQD PM<sub>2.5</sub> monitoring sites, ranked by number of parameters monitored.

Maricopa County AQD Site	AQS Identifier	Acronym	Total Number of Parameters Monitored	Score
West Phoenix	04-013-0019	WP	7	3
Mesa	04-013-1003	ME	5	2
North Phoenix	04-03-1004	NP	5	2
South Phoenix	04-013-4003	SP	5	2
Tempe	04-013-4005	TE	5	2
Durango Complex	04-013-9812	DC	4	1
Glendale	04-013-2001	GL	4	1
Diablo	04-013-4019	DI	4	1
Thirty-Third	04-013-4020	TT	*	-

\*Not included in analysis due to limited operating time

**Table 3.1.6.** All MCAQD SO<sub>2</sub> monitoring sites, ranked by number of parameters monitored.

Maricopa County AQD Site	AQS Identifier	Acronym	Total Number of Parameters Monitored	Score
Central Phoenix	04-013-3002	CP	6	2
Durango Complex	04-013-9812	DC	4	1

### 3.2 Analysis #2: Trends Impact

Analysis #2 is based on the historical monitoring record of the site, i.e., the length of time for which the site or monitor has been in operation. Monitors that have a long historical record are valuable for tracking trends; continuation of that long unbroken monitoring record is desirable in the network. Therefore, those monitors with the longest unbroken historical monitoring record score the highest.

This analysis simply considers how many years a monitor has been operating continuously. Note that if a monitor had alternating periods of operation other than seasonal, then only the most recent operating period is considered. Seasonal monitors, i.e., those CO and previously O<sub>3</sub> monitors designated to operate only during their respective seasons, are counted as if they were in continual operation.

Note that two sites, South Phoenix and West Chandler, have been relocated at some point in their history, and their AQS numbers changed due to the distance from the original site. These relocations were required by changes in the original host locations, and the new locations were chosen to represent the original location as closely as possible.

A drawback to this analysis is that it does not consider any changes in other variables that may affect the area of the monitoring site, such as population density or emission source mix.

#### 3.2.1 Results for All Parameters

**Table 3.2.1.** All MCAQD CO monitoring sites, ranked by length of monitoring record.

MCAQD Site Name	Acronym	Length of Continuous Monitoring Record (in years, as of 2019)	Score
Central Phoenix	CP	53	7
South Phoenix	SP	45*	6
Mesa	ME	41	5
West Phoenix	WP	35	4
West Chandler	WC	26**	3
Buckeye	BE	15	2
Diablo	DI	5	1
Greenwood	GR	Site closed Jun 2016	-
Thirty-third	TT	#	-

\* includes former South Phoenix AQS# 04-013-0013 site.

\*\* includes former West Chandler AQS# 04-013-3009 site.

# Not included due to limited operating time.

**Table 3.2.2.** All MCAQD NO<sub>2</sub> monitoring sites, ranked by length of monitoring record.

MCAQD Site Name	Acronym	Length of Continuous Monitoring Record (in years, as of 2019)	Score
Central Phoenix	CP	52	5
West Phoenix	WP	29	4
Buckeye	BE	15	3
Diablo	DI	5	2
Thirty-third	TT	4	1
Greenwood	GR	Site closed Jun 2016	-

**Table 3.2.3.** All MCAQD O<sub>3</sub> monitoring sites, ranked by length of monitoring record.

MCAQD Site Name	Acronym	Length of Continuous Monitoring Record (in years, as of 2019)	Score
Central Phoenix	CP	52	13
Glendale	GL	45	12
South Scottsdale	SS	45	12
North Phoenix	NP	44	11
South Phoenix	SP	44*	11
West Phoenix	WP	35	10
Pinnacle Peak	PP	31	9
Falcon Field	FF	30	8
Blue Point	BP	26	7
Humboldt Mountain	HM	26	7
West Chandler	WC	26**	7
Fountain Hills	FH	23	6
Tempe	TE	19	5
Cave Creek	CC	18	4
Dysart	DY	16	3
Buckeye	BE	15	2
Mesa	ME	7	1
Rio Verde	RV	Site closed Oct 2017	-

\* includes former South Phoenix 04-013-0013 site

\*\* includes former West Chandler 04-013-3009 site

**Table 3.2.4.** All MCAQD PM<sub>10</sub> monitoring sites, ranked by length of monitoring record.

MCAQD Site Name	Acronym	Length of Continuous Monitoring Record (in years, as of 2019)	Score
Central Phoenix	CP	34	12
South Phoenix	SP	34*	12
Glendale	GL	32	11
South Scottsdale	SS	32	11
West Phoenix	WP	31	10
Mesa	ME	29	9
North Phoenix	NP	29	9
West Chandler	WC	26**	8
Durango Complex	DC	20	7
Higley	HI	19	6
West 43 <sup>rd</sup> Avenue	WF	17	5
Dysart	DY	16	4
Buckeye	BE	15	3
Zuni Hills	ZH	10	2
Tempe	TE	7	1
Greenwood	GR	Site closed Jun 2016	-

\* includes former South Phoenix 04-013-0013 site

\*\* includes former West Chandler 04-013-3009 site

**Table 3.2.5.** All MCAQD PM<sub>2.5</sub> monitoring sites, ranked by length of monitoring record.

MCAQD Site Name	Acronym	Length of Continuous Monitoring Record (in years, as of 2019)	Score
West Phoenix	WP	19	6
Mesa	ME	14	5
South Phoenix	SP	14	5
Durango Complex	DC	9	4
Glendale	GL	8	3
North Phoenix	NP	8	3
Tempe	TE	7	2
Diablo	DI	5	1
Thirty-Third	TT	*	-

\*Not included in analysis due to limited operating time

**Table 3.2.6.** All MCAQD SO<sub>2</sub> monitoring sites, ranked by length of monitoring record.

MCAQD Site Name	Acronym	Length of Continuous Monitoring Record (in years, as of 2019)	Score
Central Phoenix	CP	54	2
Durango Complex	DC	8	1

### 3.3 Analysis #3: Measured Concentrations

This analysis ranks pollutant monitors based upon the concentrations recorded. The analysis is based upon the official design value of each pollutant monitor operating at a site. Official design values vary with each pollutant, but are often a 3-year average of the highest annual concentration metric recorded; however, this analysis will use annual concentrations. Monitors with higher design values are ranked higher than those with lower design values.

The assumption of this analysis is that sites with the highest concentrations are more important for assessing NAAQS compliance, population exposure, and performing model evaluations. A drawback of this analysis is that it does not consider any kind of monitor siting issues; a monitor might not measure maximum concentrations if it has not been sited optimally. Additionally, since this analysis focuses only on those monitors with high concentrations (often urban monitors in high-population areas), it does not consider low-concentration monitors that are important for other reasons, such as rural monitors that measure background pollutant concentrations.

#### 3.3.1 Results for All Parameters

**Table 3.3.1.** MCAQD CO monitoring sites, ranked by highest design value.

*Note that CO does not have an official design value, so the maximum annual 1-hour concentration was used.*

MCAQD Site Name	Design Value (Max 1-hour concentration, in ppm)						Score
	2015	2016	2017	2018	2019	Average	
West Phoenix	4.2	3.9	4.6	5.0	3.1	4.16	7
South Phoenix	3.0	3.2	3.5	3.7	2.6	3.2	6
Central Phoenix	2.8	3.2	3.4	3.4	2.5	3.06	5
Mesa	2.2	1.9	2.2	2.1	1.6	2	4
Diablo	1.9	2.0	2.0	2.0	1.8	1.94	3
West Chandler	1.8	2.0	1.8	2.4	1.6	1.92	2
Buckeye	0.8	1.2	0.8	0.8	1.7	1.06	1
Dysart	1.2	0.9	*	*	*	1.05	-
Greenwood	3.4	2.9	*	*	*	3.15	-
Glendale	1.9	2.0	*	*	*	1.95	-
North Phoenix	1.9	1.8	*	*	*	1.85	-
South Scottsdale	3.3	4.6	*	*	*	3.95	-
Tempe	1.8	2.0	*	*	*	1.9	-
Thirty-third	3.4	2.9	*	*	*	3.15	-

\*Not included in analysis due to limited operating time and/or monitor was closed

**Table 3.3.2.** MCAQD NO<sub>2</sub> monitoring sites, ranked by highest design value (annual 98th percentile of 1-hour daily maximum concentrations).

MCAQD Site Name	Design Value (Annual 98 <sup>th</sup> Percentile, in ppb)						Score
	2015	2016	2017	2018	2019	Average	
Thirty-third	64	63	67	62	58	62.8	5
Central Phoenix	59	59	62	56	52	57.6	4

Diablo	53	54	58	56	50	54.2	3
West Phoenix	55	54	56	52	47	52.8	2
Buckeye	34	29	34	34	33	32.8	1
Greenwood	61	59	*	*	*	60	-

\* Greenwood monitor was closed June 2016

**Table 3.3.3.** MCAQD O<sub>3</sub> monitoring sites, ranked by highest design value (annual 4th highest 8-hour concentration).

MCAQD Site Name	Design Value (Annual 4 <sup>th</sup> Highest 8-hour concentration, in ppb)						Score
	2015	2016	2017	2018	2019	Average	
Mesa	77	75	78	77	76	76.6	16
Pinnacle Peak	77	74	77	80	74	76.4	15
North Phoenix	74	75	78	77	73	75.4	14
Falcon Field	72	73	78	76	75	74.8	13
Blue Point	73	71	74	78	73	73.8	12
Humboldt Mountain	73	72	74	75	74	73.6	11
West Phoenix	74	71	77	74	70	73.2	10
Central Phoenix	71	70	75	71	73	72.0	9
South Phoenix	70	67	73	72	73	71.0	8
West Chandler	70	69	74	69	73	71.0	8
Cave Creek	69	71	71	74	69	70.8	7
Fountain Hills	69	68	73	76	67	70.6	6
Dysart	67	63	76	77	68	70.2	5
South Scottsdale	68	70	70	70	68	69.2	4
Glendale	67	66	71	70	68	68.4	3
Buckeye	60	59	70	69	62	64.0	2
Tempe	51	68	65	69	65	63.6	1
Rio Verde	68	70	68	*	*	68.7	-

\*Rio Verde monitor closed in October 2017

**Table 3.3.4.** MCAQD PM<sub>10</sub> monitoring sites, ranked by highest design value after exceptional events were excluded from these values.

*Note that the actual design value is the annual number of expected exceedances, but as these design values are often zero and are not easily analyzed, this was substituted with the cardinal maximum daily value.*

MCAQD Site Name	Design Value (Maximum 24-hour average, in µg/m <sup>3</sup> )						Score
	2015	2016	2017	2018	2019	Average	
West 43rd	132	127	160	153	150	144.4	14
Higley	147	153	-	-	114	138	13
Buckeye	124	153	150	126	131	136.8	12
Durango Complex	100	112	170	154	123	131.8	11
West Chandler	121	134	134	131	76	119.2	10
Zuni Hills	81	140	123	138	113	119	9

Central Phoenix	114	106	126	146	84	115.2	8
South Scottsdale	86	115	129	141	74	109	7
Dysart	99	126	125	120	73	108.6	6
North Phoenix	79	141	122	147	50	107.8	5
South Phoenix	86	130	129	96	72	102.6	4
West Phoenix	72	138	119	122	58	101.8	3
Mesa	66	100	141	154	48	101.8	3
Glendale	78	131	136	109	44	99.6	2
Tempe	52	77	124	151	67	94.2	1
Greenwood	106	108	*	*	*	*	-

\*The Greenwood site was closed in June 2016 and was not included in the analysis.

**Table 3.3.5.** MCAQD PM<sub>2.5</sub> monitoring sites, ranked by highest design value.

MCAQD Site Name	Design value (Annual 98 <sup>th</sup> Percentile, in µg/m <sup>3</sup> )						Score
	2015	2016	2017	2018	2019	Average	
West Phoenix	27.5	23.8	30.2	28.6	23.4	26.7	8
Durango Complex	27.1	22.7	30.6	25.7	21.7	25.6	7
South Phoenix	27.7	22.8	25	27.4	21.4	24.9	6
Diablo	17	16.6	21.3	19.9	13.7	17.7	5
Glendale	18.9	17.7	16.7	19.4	15.1	17.6	4
North Phoenix	17.8	16.3	18.9	18.2	14.5	17.1	3
Mesa	16.6	14	19	16.6	11.1	15.5	2
Tempe	16.9	14.9	16.2	16	11.9	15.2	1
Thirty-third	*	*	*	*	*	*	-

\*Not included in analysis due to limited operating time

**Table 3.3.6.** MCAQD SO<sub>2</sub> monitoring sites, ranked by highest design value (annual 99th percentile of 1-hour daily maximum concentrations).

MCAQD Site Name	Design Value (Annual Avg 1-hour 99th Percentile, in ppb)						Score
	2015	2016	2017	2018	2019	Average	
Durango Complex	9	6	10	8	5	7.6	2
Central Phoenix	7	7	8	8	5	7.0	1

### 3.4 Analysis #4: Deviation from the National Ambient Air Quality Standards

This analysis, like the Measured Concentration analysis, also uses the design value from each monitor. Unlike the previous analysis, however, this technique uses the absolute value between the design value and the NAAQS. Monitors whose design values are closest to the standard, either below or above, are given the highest rank.

The objective of this technique is to give weight to sites that are closest to the NAAQS, thus considering them to be more important for determining NAAQS compliance. Sites close to the standard are important because they could more easily influence compliance either way. The disadvantage to this technique is that it uses a narrow focus that does not consider the importance of having a monitor in a highly polluted area with concentrations well above the NAAQS or having a monitor measuring background concentration well below the NAAQS.

#### 3.4.1 Results for All Parameters

**Table 3.4.1.** List of MCAQD CO monitoring sites, ranked by deviation from the NAAQS.

MCAQD Site Name	Design Value (Maximum 1-hour average, in ppm)								Score
	2015	2016	2017	2018	2019	Average	NAAQS	Deviance	
West Phoenix	4.2	3.9	4.6	5	3.1	4.16	35	-30.84	7
South Phoenix	3	3.2	3.5	3.7	2.6	3.20	35	-31.80	6
Central Phoenix	2.8	3.2	3.4	3.4	2.5	3.06	35	-31.94	5
Mesa	2.2	1.9	2.2	2.1	1.6	2.00	35	-33.00	4
Diablo	1.9	2	2	2	1.8	1.94	35	-33.06	3
West Chandler	1.8	2	1.8	2.4	1.6	1.92	35	-33.08	2
Buckeye	0.8	1.2	0.8	0.8	1.7	1.06	35	-33.94	1
Dysart	1.2	0.9	*	*	*	1.05	35	-33.95	-
Greenwood	3.4	2.9	*	*	*	3.15	35	-31.85	-
Glendale	1.9	2.0	*	*	*	1.95	35	-33.05	-
North Phoenix	1.9	1.8	*	*	*	1.85	35	-33.15	-
South Scottsdale	3.3	4.6	*	*	*	3.95	35	-31.05	-
Tempe	1.8	2.0	*	*	*	1.9	35	-33.1	-
Thirty-third	3.4	2.9	*	*	*	3.15	35	-31.85	-

\*Not included in analysis due to limited operating time and/or monitor was closed

**Table 3.4.2.** List of MCAQD NO<sub>2</sub> monitoring sites, ranked by deviation from the NAAQS.

MCAQD Site Name	Design Value (Annual average concentration, in ppm)								Score
	2015	2016	2017	2018	2019	Average	NAAQS	Deviance	
Thirty-Third	-	30.9	30.6	28.3	24.8	28.65	53	-24.35	5
Diablo	21.4	21.5	21.7	18.9	16.8	20.06	53	-32.94	4
Central Phoenix	17.9	17.3	18.2	17.5	15.7	17.32	53	-35.68	3
West Phoenix	16.4	16.2	17	16.1	14.1	15.96	53	-37.04	2
Buckeye	7.1	6.9	7.7	7.7	7.1	7.30	53	-45.70	1
Greenwood	21.9	*	*	*	*	*	*	*	-

\* Greenwood monitor was closed in June 2016

**Table 3.4.3.** List of MCAQD O<sub>3</sub> monitoring sites, ranked by deviation from the NAAQS.

MCAQD Site Name	Design Value (annual 4 <sup>th</sup> highest 8-hour concentration, in ppb)								Score
	2015	2016	2017	2018	2019	Average	NAAQS	Deviance	
Falcon Field	72	73	78	76	75	74.8	75	-0.2	15
North Phoenix	74	75	78	77	73	75.4	75	0.4	14
Blue Point	73	71	74	78	73	73.8	75	-1.2	13
Pinnacle Peak	77	74	77	80	74	76.4	75	1.4	12
Humboldt	73	72	74	75	74	73.6	75	-1.4	12
Mesa	77	75	78	77	76	76.6	75	1.6	11
West Phoenix	74	71	77	74	70	73.2	75	-1.8	10
Central Phoenix	71	70	75	71	73	72	75	-3	9
South Phoenix	70	67	73	72	73	71	75	-4	8
West Chandler	70	69	74	69	73	71	75	-4	8
Cave Creek	69	71	71	74	69	70.8	75	-4.2	7
Fountain Hills	69	68	73	76	67	70.6	75	-4.4	6
Dysart	67	63	76	77	68	70.2	75	-4.8	5
South Scottsdale	68	70	70	70	68	69.2	75	-5.8	4
Glendale	67	66	71	70	68	68.4	75	-6.6	3
Buckeye	60	59	70	69	62	64	75	-11	2
Tempe	51	68	65	69	65	63.6	75	-11.4	1
Rio Verde	68	70	68	*	*	68.7	75	-6.3	-

\*Rio Verde monitor closed in October 2017

**Table 3.4.4.** List of MCAQD PM<sub>10</sub> monitoring sites, ranked by deviation from the NAAQS.

MCAQD Site Name	Design Value (Maximum 24-hour average, in µg/m <sup>3</sup> )								Score
	2015	2016	2017	2018	2019	Average	NAAQS	Deviance	
West 43rd	132	127	160	153	150	144.4	150	-5.6	14
Higley	147	153	-	-	114	138	150	-12	13
Buckeye	124	153	150	126	131	136.8	150	-13.2	12
Durango Complex	100	112	170	154	123	131.8	150	-18.2	11
West Chandler	121	134	134	131	76	119.2	150	-30.8	10
Zuni Hills	81	140	123	138	113	119	150	-31	9
Central Phoenix	114	106	126	146	84	115.2	150	-34.8	8
South Scottsdale	86	115	129	141	74	109	150	-41	7
Dysart	99	126	125	120	73	108.6	150	-41.4	6
North Phoenix	79	141	122	147	50	107.8	150	-42.2	5
South Phoenix	86	130	129	96	72	102.6	150	-47.4	4
Mesa	66	100	141	154	48	101.8	150	-48.2	3
West Phoenix	72	138	119	122	58	101.8	150	-48.2	3
Glendale	78	131	136	109	44	99.6	150	-50.4	2
Tempe	52	77	124	151	67	94.2	150	-55.8	1
Greenwood	106	*	*	*	*	*	150	*	-

**Table 3.4.5.** List of MCAQD PM<sub>2.5</sub> monitoring sites, ranked by deviation from the NAAQS.

MCAQD Site Name	Design value (annual 98th percentile, in µg/m <sup>3</sup> )								Score
	2015	2016	2017	2018	2019	Average	NAAQS	Deviance	
West Phoenix	27.5	23.8	30.2	28.6	23.4	26.7	35	-8.3	8
Durango Complex	27.1	22.7	30.6	25.7	21.7	25.6	35	-9.4	7
South Phoenix	27.7	22.8	25	27.4	21.4	24.9	35	-10.1	6
Diablo	17	16.6	21.3	19.9	13.7	17.7	35	-17.3	5
Glendale	18.9	17.7	16.7	19.4	15.1	17.6	35	-17.4	4
North Phoenix	17.8	16.3	18.9	18.2	14.5	17.1	35	-17.9	3
Mesa	16.6	14	19	16.6	11.1	15.5	35	-19.5	2
Tempe	16.9	14.9	16.2	16	11.9	15.2	35	-19.8	1
Thirty-third	*	*	*	*	*	*	*	*	-

\*Not included in analysis due to limited operating time

**Table 3.4.6.** List of MCAQD SO<sub>2</sub> monitoring sites, ranked by deviation from the NAAQS.

MCAQD Site Name	Design Value (annual avg 1-hour 99th percentile, in ppb)								Score
	2015	2016	2017	2018	2019	Average	NAAQS	Deviance	
Durango	9	6	10	8	5	7.6	75	-67.4	2
Central Phoenix	7	7	8	8	5	7.0	75	-68.0	1

### 3.5 Analysis #5: Area Served

This test analyzes the spatial coverage of each monitor by using the technique of applying Thiessen proximity polygons that represent a monitor's geographic coverage area. This is a standard technique used in geography to assign a zone of influence around a point. Thiessen polygons are created by delineating those areas around the monitoring point that are closer than any other monitoring point<sup>2</sup>. Since the individual monitoring site under consideration houses the closest monitor(s) within its perspective Thiessen polygon, the monitor(s) is used to represent the entire area of the polygon. Larger Thiessen polygons (measured by km<sup>2</sup>) will score higher because they serve larger areas and have been weighted accordingly.

The advantage of this technique is that it utilizes a simple method to give weight to a monitor's boundaries of influence. Monitors that are on the boundary of the urban area or in a rural area will tend to serve larger areas and therefore will have a higher rank. These sites are valuable for interpolation purposes, determining background concentrations, and adding spatial coverage to a large metropolitan area. Also, removing these monitors from the network would give those areas less representation since there is more distance to the next nearest monitor.

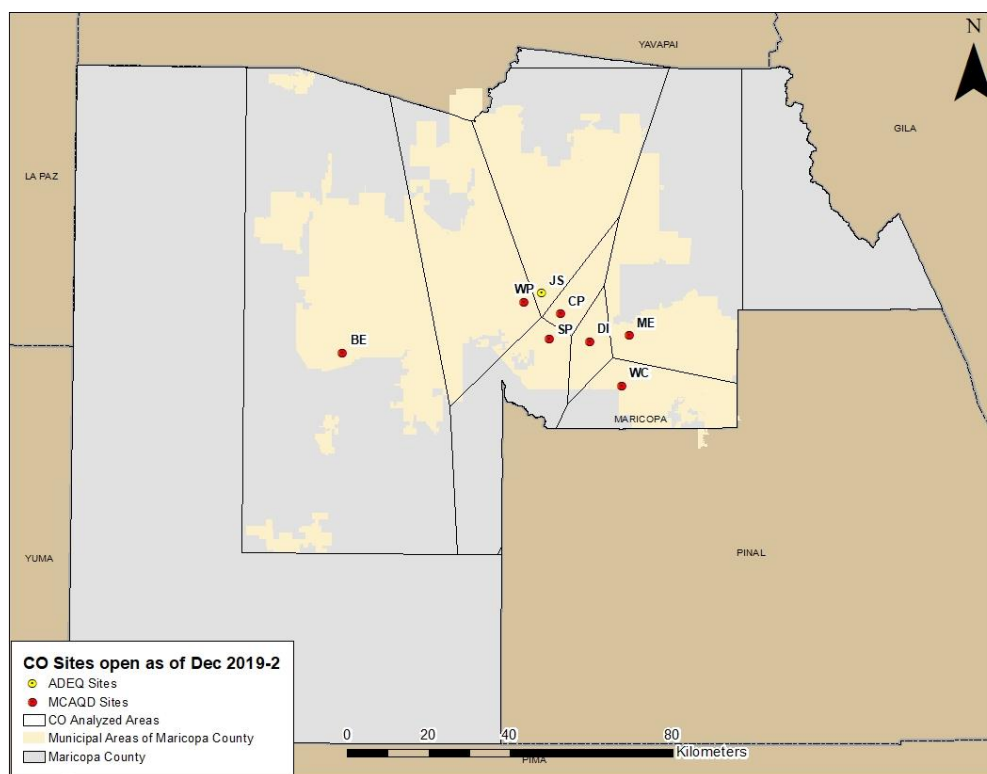
Note that this technique is purely spatial in nature, and its major disadvantage is that it does not consider meteorology, landscape topography, or proximity to pollution sources. Thus, an area within one polygon might, in reality, be better represented by another monitor. For instance, prevailing wind currents could push emission plumes away from the polygon's monitoring point. Another disadvantage is that the polygon might be so large that its monitoring point cannot adequately represent the outer edges of the area; however, that monitoring site *most closely* represents the area spatially.

To create an accurate analysis, monitoring sites from Gila, La Paz, Pinal, Pima, Yavapai, and Yuma counties, as well as monitors from all the tribal agencies within these counties, were included in the creation of the Thiessen polygons. The Thiessen polygon was clipped to the rectangular extent of the metropolitan areas (including the towns of Wickenburg and Gila Bend) of Maricopa County and then to the borders of the county itself before the area of the polygon was recorded. If it wasn't possible to extend the areas served outside of Maricopa County, such as in the case of a lack of surrounding monitors in other counties, then the area reported has an outside boundary set to the rectangular extent of the Phoenix metropolitan area and then clipped to the borders of Maricopa County; this was the technique used to determine the area of the CO, NO<sub>2</sub>, and SO<sub>2</sub> parameters. This analysis does not include sites that closed before 2019, though sites that began operating by 2019 are included.

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<sup>2</sup> O'Sullivan, D. & Unwin, D. J. (2003) *Geographic Information Analysis*. John Wiley & Sons, Inc, Hoboken, New Jersey.

### 3.5.1 CO Parameter Details



**Figure 3.5.1.** Thiessen polygons for CO monitoring sites. Note that the analysis is set to the rectangular extent of the Phoenix metropolitan area and then clipped to the Maricopa County border.

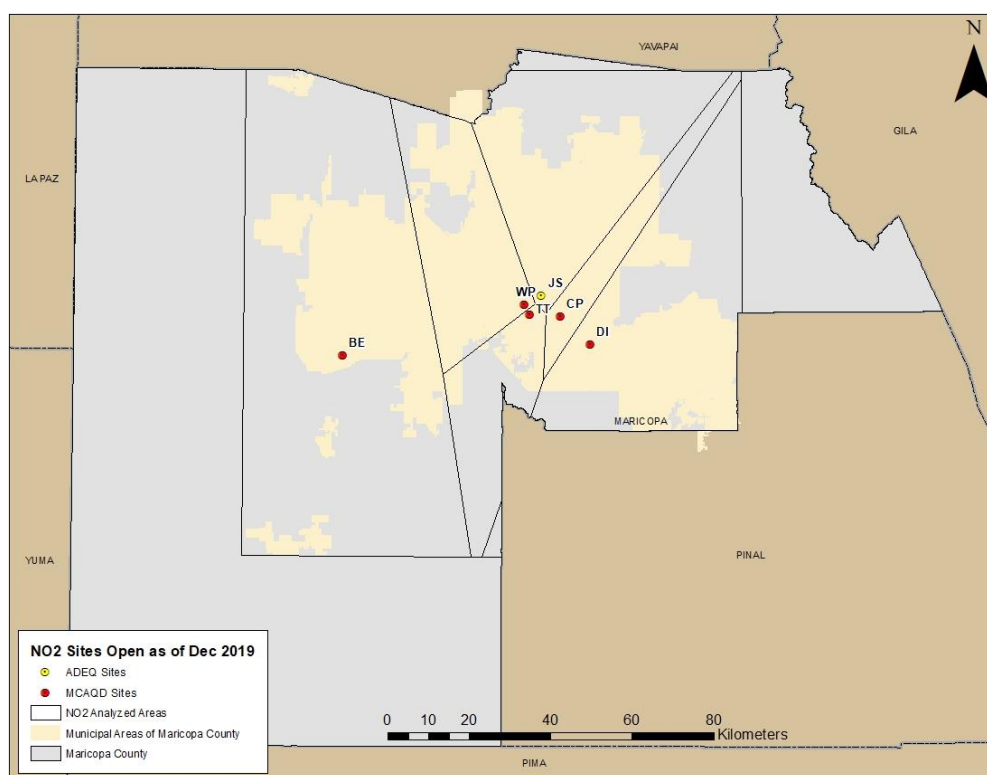
**Table 3.5.1.** CO monitoring sites, ranked by area served within Maricopa County.

Site	AQS Identifier	Acronym	Area Served (km <sup>2</sup> )	Score
Buckeye	04-013-4011	BE	5,317	7
Mesa	04-013-4003	ME	2,070	6
West Phoenix	04-013-0019	WP	1,449	5
South Phoenix	04-013-1004	SP	837	4
West Chandler	04-013-3003	WC	572	3
Central Phoenix	04-013-3002	CP	180	2
Diablo	04-013-4019	DI	174	1
Dysart	04-013-4010	DY	*	-
Glendale	04-013-2001	GL	*	-
Greenwood	04-013-3010	GR	*	-
North Phoenix	04-013-4004	NP	*	-
South Scottsdale	04-013-1003	SS	*	-
Tempe	04-013-4005	TE	*	-
Thirty-third	04-013-4020	TT	**	-

\*These CO sites were closed before December 2019 and were not included in the analysis.

\*\*Not included in analysis due to limited operating time

### 3.5.2 NO<sub>2</sub> Parameter Details



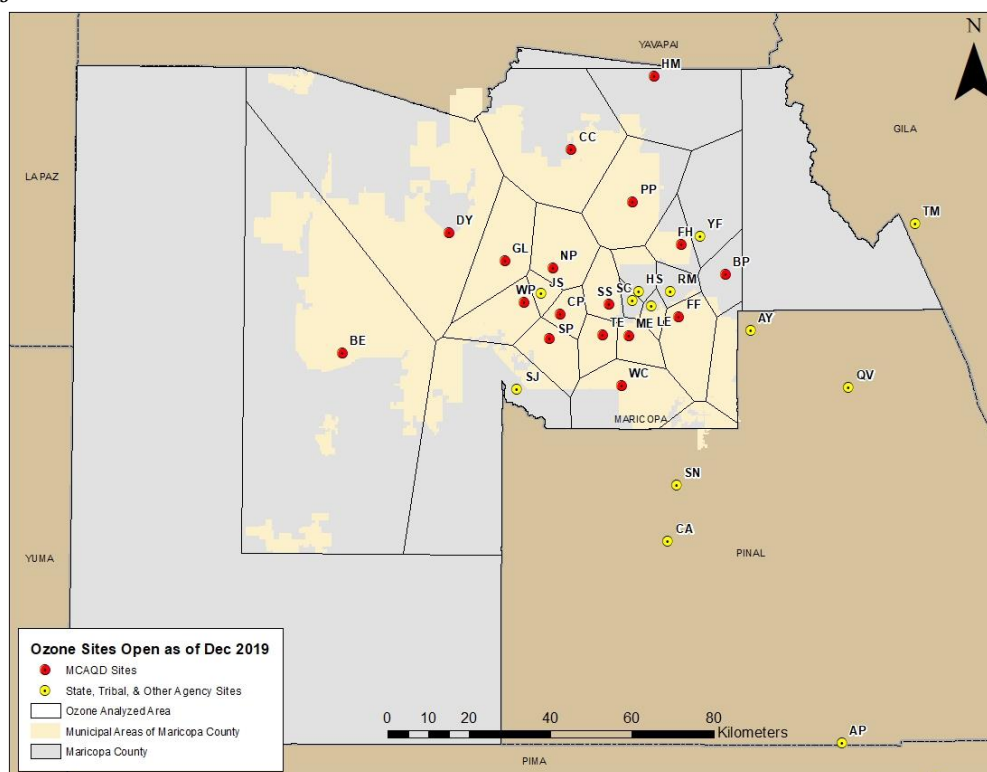
**Figure 3.5.2.** Thiessen polygons for NO<sub>2</sub> monitoring sites. Note that the analysis is set to the rectangular extent of the Phoenix metropolitan area and then clipped to the Maricopa County border.

**Table 3.5.2.** NO<sub>2</sub> monitoring sites, ranked by area served within Maricopa County.

Maricopa County AQD Site	AQS Identifier	Acronym	Area Served (km <sup>2</sup> )	Score
Buckeye	04-013-4011	BE	5,370	5
Diablo	04-013-4019	DI	2,423	4
West Phoenix	04-013-0019	WP	1,278	3
Thirty-third	04-013-4020	TT	769	2
Central Phoenix	04-013-3002	CP	482	1
Greenwood	04-013-3010	GR	*	-

\*The Greenwood site was closed in June 2016 and was not included in the analysis.

### 3.5.3 O<sub>3</sub> Parameter Details



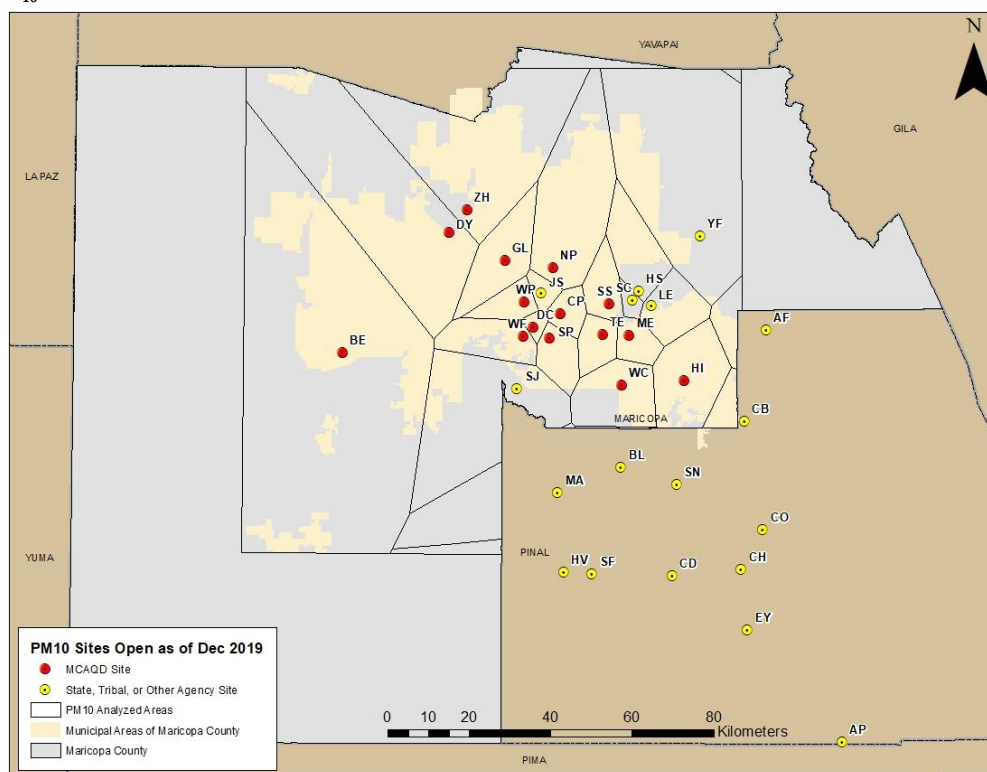
**Figure 3.5.3.** Thiessen polygons for O<sub>3</sub> monitoring sites. Note that the analysis is set to the rectangular extent of the Phoenix metropolitan area and then clipped to the Maricopa County border.

**Table 3.5.3.** O<sub>3</sub> monitoring sites, ranked by area served within Maricopa County.

Maricopa County AQD Site	AQS Identifier	Acronym	Area Served (km <sup>2</sup> )	Score
Buckeye	04-013-4011	BE	3,646	17
Dysart	04-013-4010	DY	2,159	16
Cave Creek	04-013-4008	CC	899	15
Humboldt Mountain	04-013-9508	HM	588	14
Pinnacle Peak	04-013-2005	PP	467	13
West Chandler	04-013-4004	WC	394	12
Glendale	04-013-2001	GL	345	11
North Phoenix	04-013-1004	NP	263	10
Falcon Field	04-013-1010	FF	260	9
West Phoenix	04-013-0019	WP	217	8
South Phoenix	04-013-4003	SP	171	7
Blue Point	04-013-9702	BP	148	6
Fountain Hills	04-013-9704	FH	139	5
South Scottsdale	04-013-3003	SS	129	4
Tempe	04-013-4005	TE	114	3
Mesa	04-013-1003	ME	106	2
Central Phoenix	04-013-3002	CP	87	1
Rio Verde	04-013-9706	RV	*	-

\*The Rio Verde site was closed in October 2017 and was not included in the analysis.

### 3.5.4 PM<sub>10</sub> Parameter Details



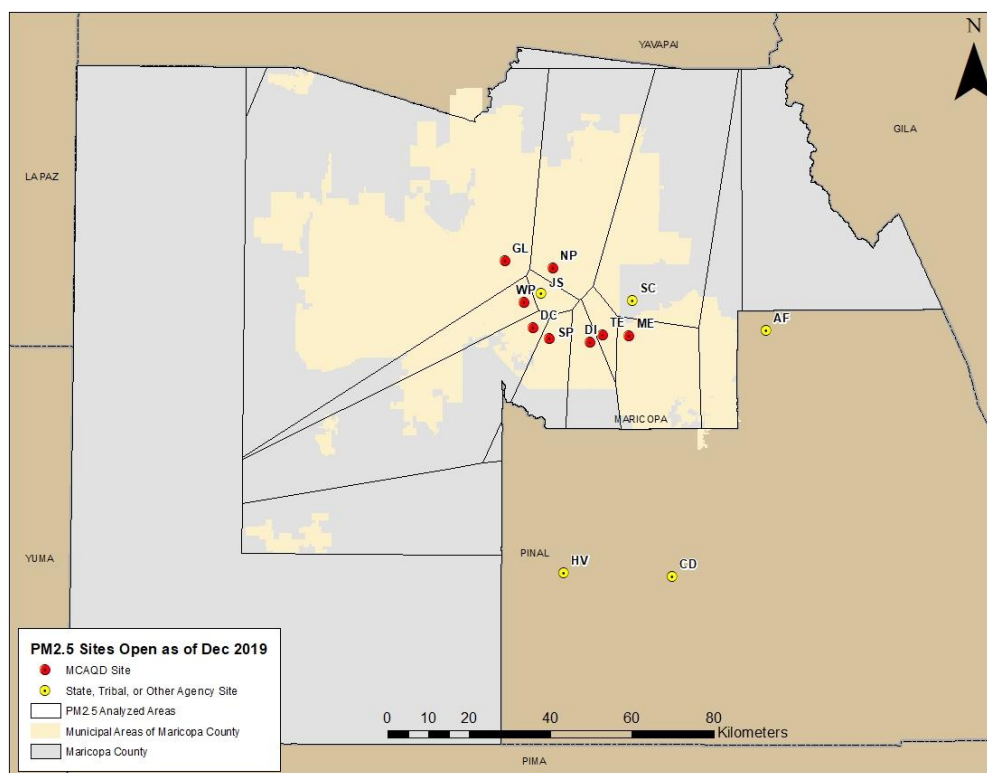
**Figure 3.5.4.** Thiessen polygons for PM<sub>10</sub> sites. Note that the analysis is set to the rectangular extent of the Phoenix metropolitan area and then clipped to the Maricopa County border.

**Table 3.5.4.** PM<sub>10</sub> monitoring sites, ranked by area served within Maricopa County.

Maricopa County AQD Site	AQS Identifier	Acronym	Area Served (km <sup>2</sup> )	Score
Buckeye	04-013-4011	BE	3,630	15
Dysart	04-013-4010	DY	1,541	14
Zuni Hills	04-013-4016	ZH	1,169	13
North Phoenix	04-013-1004	NP	728	12
Higley	04-013-4006	HI	364	11
West Chandler	04-013-4004	WC	298	10
Glendale	04-013-2001	GL	290	9
West 43rd Ave	04-013-4009	WF	215	8
South Scottsdale	04-013-3003	SS	134	7
South Phoenix	04-013-4003	SP	129	6
Tempe	04-013-4005	TE	114	5
West Phoenix	04-013-0019	WP	104	4
Mesa	04-013-1003	ME	101	3
Central Phoenix	04-013-3002	CP	86	2
Durango Complex	04-013-9812	DC	29	1
Greenwood	04-013-3010	GR	*	-

\*The Greenwood site was closed in June 2016 and was not included in the analysis.

### 3.5.5 PM<sub>2.5</sub> Parameter Details



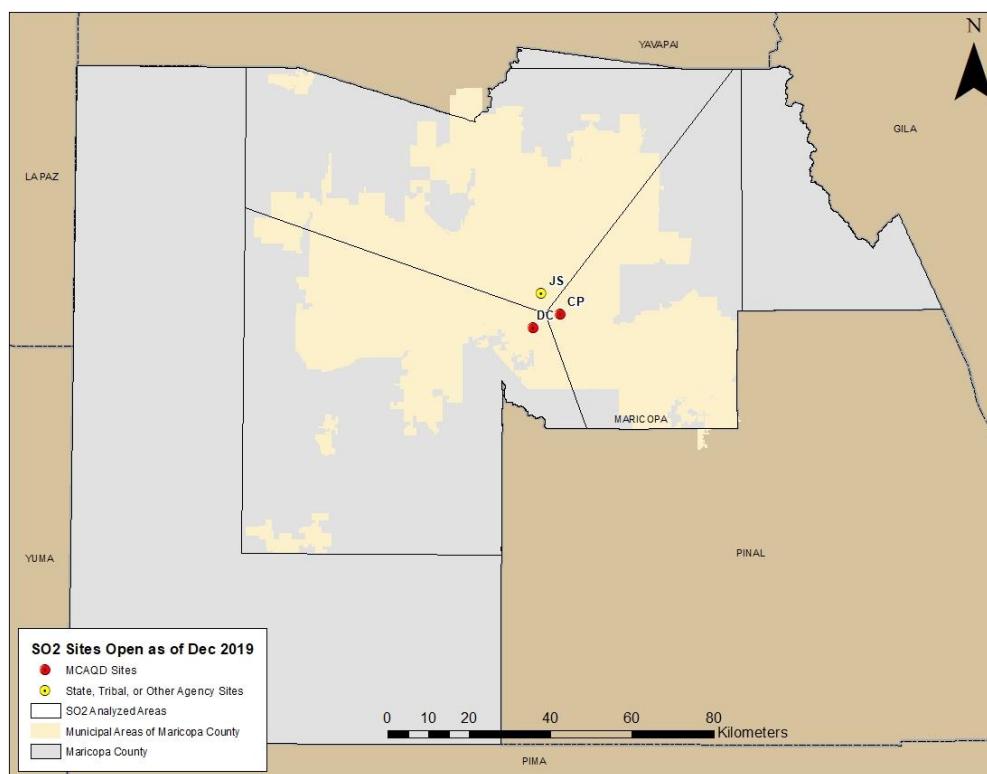
**Figure 3.5.5.** Thiessen polygons for PM<sub>2.5</sub> monitoring sites. Note that the analysis is set to the rectangular extent of the Phoenix metropolitan area and then clipped to the Maricopa County border.

**Table 3.5.5.** PM<sub>2.5</sub> monitoring sites, ranked by area served within Maricopa County.

Maricopa County AQD Site	AQS Identifier	Acronym	Area Served (km <sup>2</sup> )	Score
Glendale	04-013-2001	GL	4,839	8
Durango Complex	04-013-9812	DC	1,480	7
North Phoenix	04-013-1004	NP	1,125	6
Mesa	04-013-1003	ME	532	5
West Phoenix	04-013-0019	WP	391	4
South Phoenix	04-013-4003	SP	284	3
Diablo	04-013-4019	DI	279	2
Tempe	04-013-4005	TE	94	1
Thirty-Third	04-013-4020	TT	*	-

\*Not included in analysis due to limited operating time

### 3.5.6 SO<sub>2</sub> Parameter Details



**Figure 3.5.6.** Thiessen polygons for SO<sub>2</sub> monitoring sites. Note that the analysis is set to the rectangular extent of the Phoenix metropolitan area and then clipped to the Maricopa County border.

**Table 3.5.6.** SO<sub>2</sub> monitoring sites, ranked by area served within Maricopa County.

Maricopa County AQD Site	AQS Identifier	Acronym	Area Served (km <sup>2</sup> )	Score
Durango Complex	04-013-9812	DC	5,111	2
Central Phoenix	04-013-3002	CP	2,706	1

### 3.6 Analysis #6: Population Served

This analysis attempts to gauge the impact of population on each monitoring site. Since areas of high population will generally have higher emissions, monitors representing more population will be of greater importance. Also, representing the air quality for the greatest number of people is critical so monitors with the highest population counts are given the highest rank.

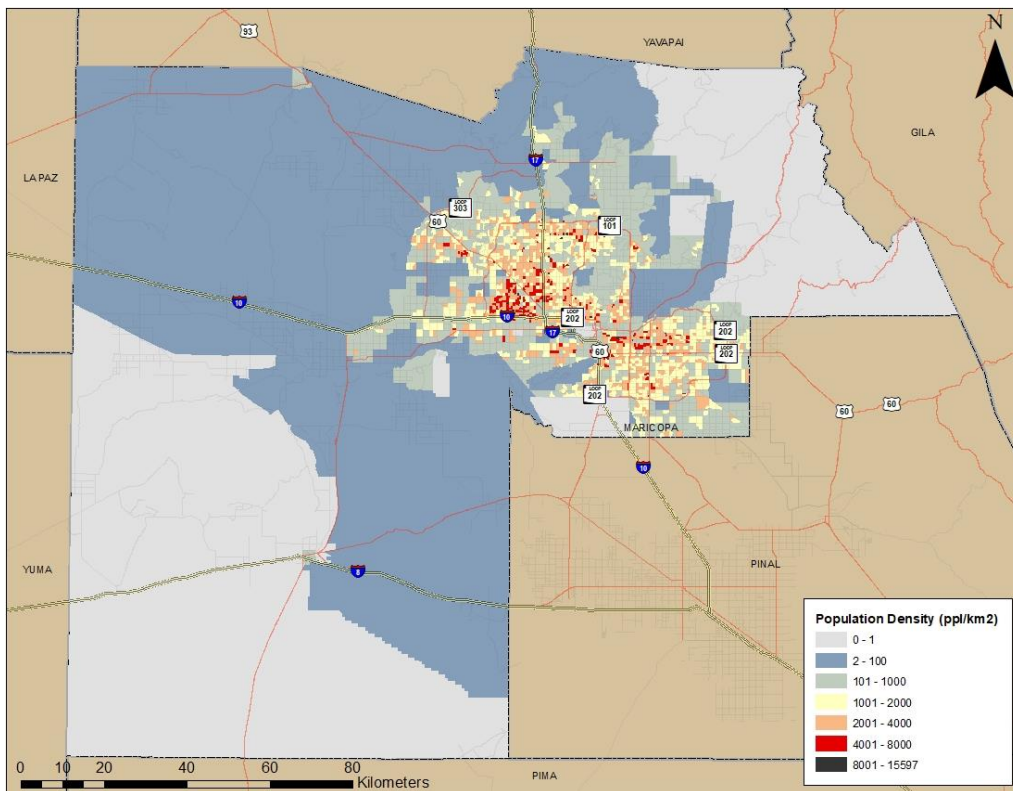
This method also relies on the Thiessen polygon technique to determine each monitor's area of representation (see Analysis #5: Area Served for more details on Thiessen polygons). Thiessen polygons were created for each monitoring site and organized by pollutant parameter. Data estimates from the 2017 American Community Survey (ACS) Census were then used within a Geographic Information System (GIS) to create a polygon coverage map of census block groups within Maricopa County. The census block group polygons were selected by their centroid point and the population within each monitor's Thiessen polygon was determined by summing those centroids that were spatially located within the polygon.

The advantage of this analysis is that by using Thiessen polygons it provides a simple technique to quantify the population represented by a particular monitor. This technique will provide more weight to sites that have a high surrounding population and a large geographic area of representation. Note that in the case of large areas of representation, a population far away from the monitoring site might not necessarily be adequately represented by that monitoring site. However, they are closest to their perspective monitoring site, so this technique assumes that monitoring site is most important for representing them.

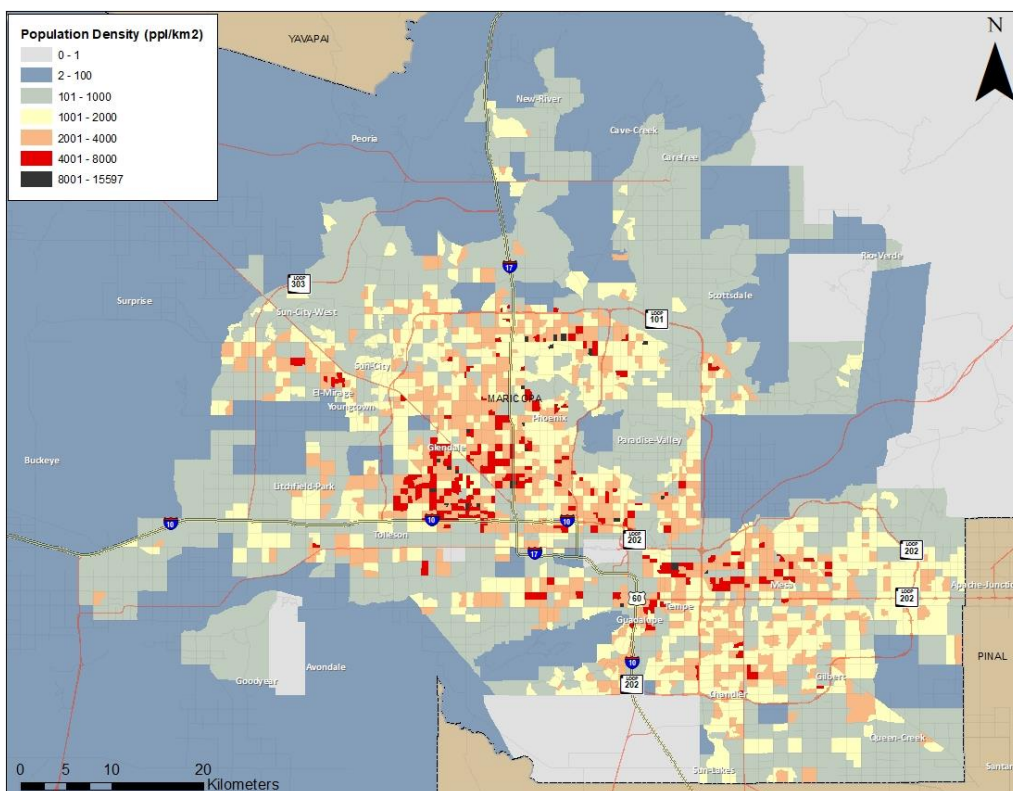
The disadvantage of this technique is the same as in the Area Served analysis; i.e. this technique is purely spatial in its construction and does not consider meteorology, topography, location of sources, etc.

The 2017 Census block groups that were used in the analysis cover the entire Maricopa County area, but only those within the greater metropolitan area were used in the analysis; see Section 3.5, Area Served Analysis, for more details on the analyzed areas. The metropolitan areas included within this analysis only contains 48.5% of the total area of Maricopa County, but contains 99.8% of the population within the County.

Figure 3.6.1 depicts population densities of Maricopa County with a close-up of the Phoenix metropolitan area in Figure 3.6.2. The population density, or people per km<sup>2</sup>, is based upon the 2017 ACS Census block groups. Illustrations of Thiessen polygons for individual pollutant parameters are contained in Figures 3.5.1 through 3.5.7.



**Figure 3.6.1.** Maricopa County population density (2017 ACS Census, #people/km<sup>2</sup>).



**Figure 3.6.2.** Maricopa County population density in the Phoenix metropolitan area urban core (2017 ACS Census, #people/km<sup>2</sup>).

### 3.6.1 CO Parameter Details

**Table 3.6.1.** CO monitoring sites ranked by population served.

Maricopa County AQD Site	Acronym	Population Served	Score
West Phoenix	WP	1,125,303	7
Mesa	ME	892,288	6
West Chandler	WC	453,714	5
Diablo	DI	242,636	4
Central Phoenix	CP	206,714	3
Buckeye	BE	194,972	2
South Phoenix	SP	179,545	1
Dysart	DY	*	-
Glendale	GL	*	-
Greenwood	GR	*	-
North Phoenix	NP	*	-
South Scottsdale	SS	*	-
Thirty-third	TT	**	-

\*These CO sites were closed before December 2019 and were not included in the analysis.

\*\*Not included due to limited operating time

Note: There are 9,895 people in Maricopa County, out of a total population of 4,155,501, who lived outside of the CO analysis area (see section 3.5.1 for details on analysis area); 843,712 people in the CO analysis area are served by monitors operated by other agencies.

### 3.6.2 NO<sub>2</sub> Parameter Details

**Table 3.6.2.** NO<sub>2</sub> monitoring sites, ranked by population served.

Maricopa County AQD Site	Acronym	Population Served	Score
Diablo	DI	1,556,700	5
West Phoenix	WP	1,057,459	4
Central Phoenix	CP	328,088	3
Buckeye	BE	194,972	2
Thirty-third	TT	161,115	1
Greenwood	GR	*	-

\*The Greenwood site was closed in June 2016 and was not included in the analysis.

Note: There are 9,895 people in Maricopa County, out of a total population of 4,155,501, who lived outside of the NO<sub>2</sub> analysis area (see section 3.5.2 for details on analysis area); 847,272 people in the NO<sub>2</sub> analysis area are served by monitors operated by other agencies.

### 3.6.3 O<sub>3</sub> Parameter Details

**Table 3.6.3.** O<sub>3</sub> monitoring sites, ranked by population served.

Maricopa County AQD Site	Acronym	Population Served	Score
Glendale	GL	554,386	17
Dysart	DY	452,871	16
North Phoenix	NP	380,825	15
West Phoenix	WP	369,107	14
West Chandler	WC	357,442	13
Falcon Field	FF	328,172	12
Mesa	ME	216,224	11
Tempe	TE	180,854	10
South Phoenix	SP	177,714	9
South Scottsdale	SS	151,846	8
Central Phoenix	CP	150,905	7
Cave Creek	CC	126,974	6
Pinnacle Peak	PP	116,486	5
Buckeye	BE	99,422	4
Fountain Hills	FH	32,353	3
Blue Point	BP	1,709	2
Humboldt Mountain	HM	0	1
Rio Verde	RV	*	-

\*The Rio Verde site was closed in October 2017 and was not included in the analysis.

Note: There are 9,895 people in Maricopa County, out of a total population of 4,155,501, who lived outside of the O<sub>3</sub> analysis area (see section 3.5.3 for details on analysis area); 448,316 people in the O<sub>3</sub> analysis area are served by monitors operated by other agencies.

### 3.6.4 PM<sub>10</sub> Parameter Details

**Table 3.6.4.** PM<sub>10</sub> monitoring sites, ranked by population served.

Maricopa County AQD Site	Acronym	Population Served	Score
Glendale	GL	491,770	15
North Phoenix	NP	490,620	14
Higley	HI	381,490	13
Dysart	DY	365,184	12
West Chandler	WC	267,731	11
West Phoenix	WP	266,439	10
Mesa	ME	202,562	9
Zuni Hills	ZH	202,466	8
Tempe	TE	180,854	7
South Scottsdale	SS	156,993	6
Central Phoenix	CP	149,157	5
West 43rd Ave	WF	148,571	4
South Phoenix	SP	129,548	3
Buckeye	BE	93,480	2
Durango Complex	DC	33,618	1
Greenwood	GR	*	-

\*The Greenwood site was closed in June 2016 and was not included in the analysis.

Note: There are 9,895 people in Maricopa County, out of a total population of 4,155,501, who lived outside of the PM<sub>10</sub> analysis area (see section 3.5.4 for details on analysis area); 585,123 people in the PM<sub>10</sub> analysis area are served by monitors operated by other agencies.

### 3.6.5 PM<sub>2.5</sub> Parameter Details

**Table 3.6.5.** PM<sub>2.5</sub> monitoring sites, ranked by population served.

Maricopa County AQD Site	Acronym	Population Served	Score
Glendale	GL	1,130,032	8
Mesa	ME	788,857	7
North Phoenix	NP	539,605	6
West Phoenix	WP	349,558	5
Diablo	DI	214,769	4
Tempe	TE	165,317	3
South Phoenix	SP	142,049	2
Durango Complex	DC	122,749	1
Thirty-Third	TT	*	-

\*Not included in analysis due to limited operating time

Note: There are 9,895 people in Maricopa County, out of a total population of 4,155,501, who lived outside of the PM<sub>2.5</sub> analysis area (see section 3.5.5 for details on analysis area); 692,670 people in the PM<sub>2.5</sub> analysis area are served by monitors operated by other agencies.

### 3.6.6 SO<sub>2</sub> Parameter Details

**Table 3.6.6.** SO<sub>2</sub> monitoring sites, ranked by population served.

Maricopa County AQD Site	Acronym	Population Served	Score
Central Phoenix	CP	1,816,630	2
Durango Complex	DC	706,834	1

Note: There were 9,895 people in Maricopa County, out of a total population of 4,155,501, who lived outside of the SO<sub>2</sub> analysis area (see section 3.5.6 for details on analysis area); 1,622,142 people in the SO<sub>2</sub> analysis area are served by monitors operated by other agencies.

### 3.7 Analysis #7: Monitor-to-Monitor Correlation

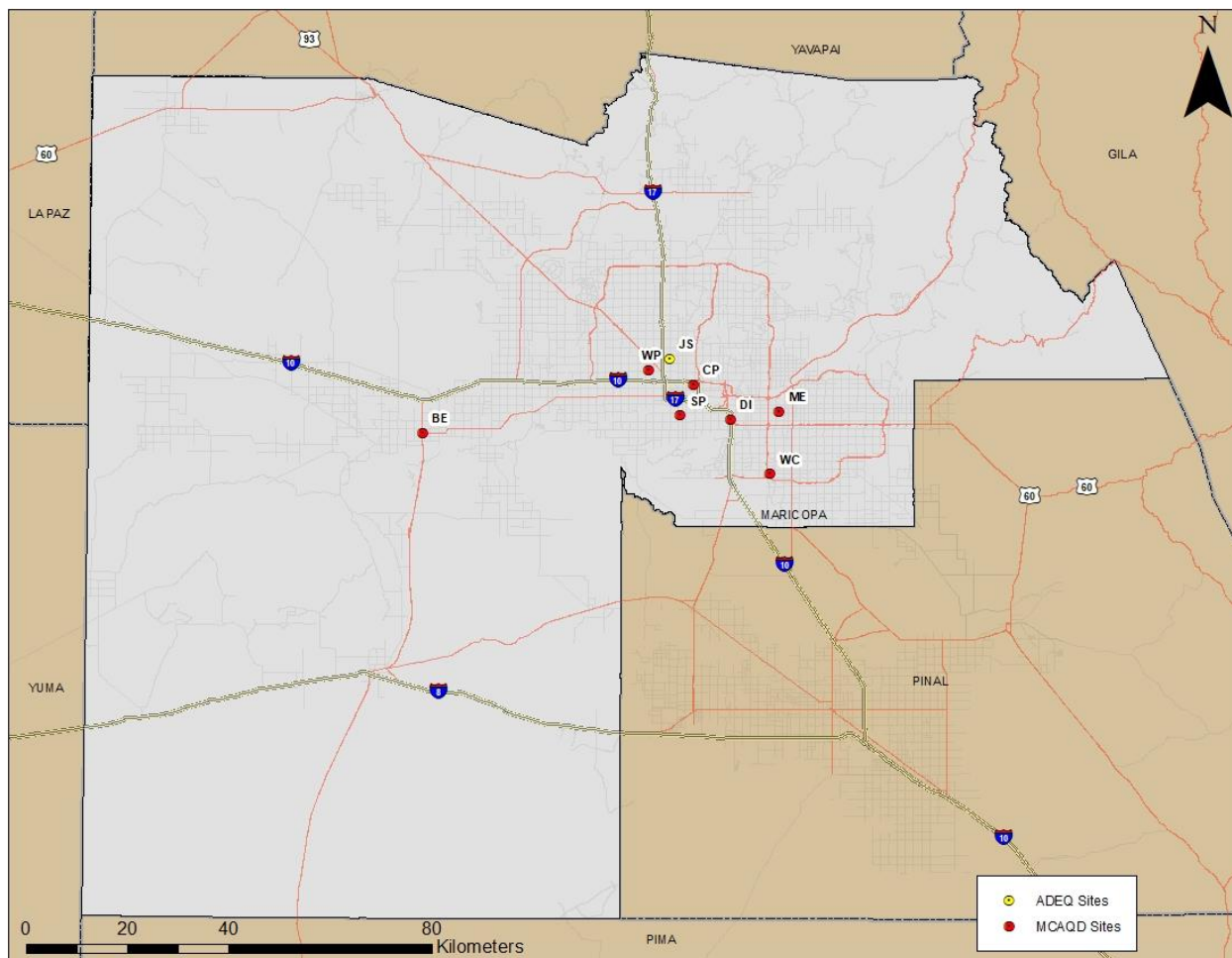
This analysis ranks monitoring sites based upon their “uniqueness”. Sites that have more unique attributes are weighted more heavily in this analysis, as they are more valuable for modeling and determining the spatial concentration of pollutants. This analysis is also useful for identifying redundant monitors. Monitor pairs that have a high correlation (e.g. > 75%) may be redundant, and this analysis can be used as a tool for indicating which monitors may be suitable for closure.

To conduct this analysis, 2019 data were collected for each criteria parameter monitored within Maricopa County, including state and tribal monitors. Data were also collected from the surrounding counties of Gila, La Paz, Pinal, Pima, Yavapai and Yuma, as appropriate, to ensure a robust sample. The concentration of each monitoring site was then compared to every other monitoring site using a matrix format. Within the matrix each monitoring pair were subjected to a Pearson correlation test where the coefficient ( $r^2$ ) was generated. The maximum correlation was then recorded for each site. Sites were scored based on their maximum correlation; higher values, showing more redundancy, received a lower score. A distance matrix between sites was also developed, and a correlogram plot of correlation versus distance was created for each parameter. The correlogram displays the relationship between correlation and distance; a regression trend line is added to determine the average correlation between sites at the specified distance. Correlograms are useful in determining the average distance of redundancy in the monitoring network.

Specific information regarding the method of collecting and correlating data for each parameter is as follows:

- CO: Hourly concentration values from 2019 were used. All monitoring site locations were within Maricopa County and included data from MCAQD and the ADEQ (JLG Supersite).
- NO<sub>2</sub>: Hourly concentration values from 2019 were used. All monitoring site locations were within Maricopa and Pima Counties and included data from MCAQD, ADEQ, and Pima County AQD.
- O<sub>3</sub>: Hourly concentration values from 2019 were used. Monitoring locations included sites within Maricopa and its surrounding counties: Gila, La Paz, Pinal, Pima, Yavapai, and Yuma and included data reported by MCAQD, ADEQ, Pinal County AQD, Pima County AQD, Gila River Indian Community, and Salt River Pima-Maricopa Indian Community.
- PM<sub>10</sub>: Hourly average concentrations from 2019 were used. Monitoring locations included sites within Maricopa and Pinal counties and included data reported by MCAQD, ADEQ, Pinal County AQD, Gila River Indian Community, and Salt River Pima-Maricopa Indian Community.
- PM<sub>2.5</sub>: Hourly average concentrations from 2019 continuous monitors were used. Monitoring locations included sites within Maricopa and Pinal counties and included data reported by MCAQD, ADEQ, and Pinal County AQD.
- SO<sub>2</sub>: Hourly concentration values from 2019 were used. Monitoring site locations were within Maricopa, Gila, and Pima counties and included data from MCAQD, ADEQ, and Pima County AQD.

### 3.7.1 CO Parameter Details

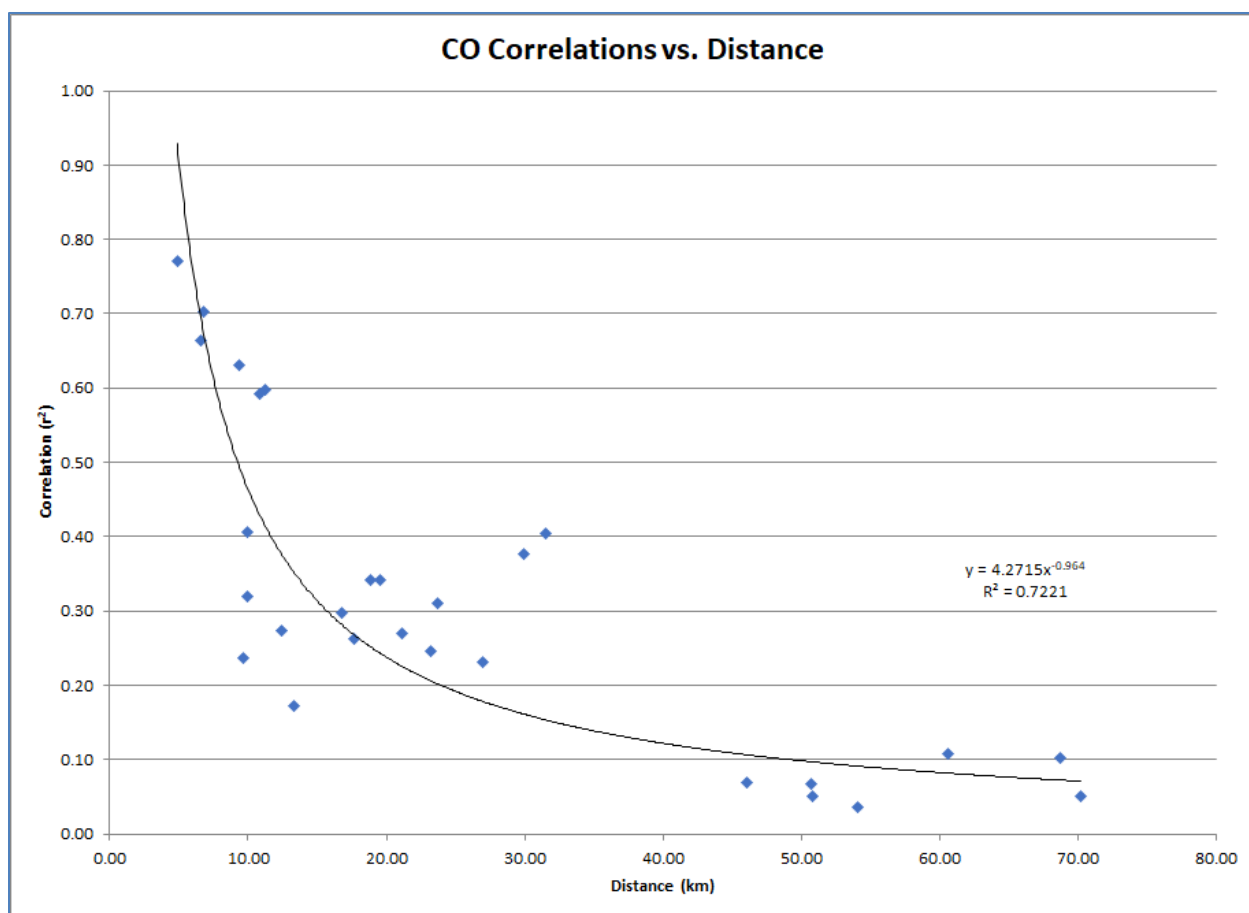


**Figure 3.7.1.** Map of CO monitoring sites used for analysis.

**Table 3.7.1.** CO monitoring sites ordered and ranked by correlation.

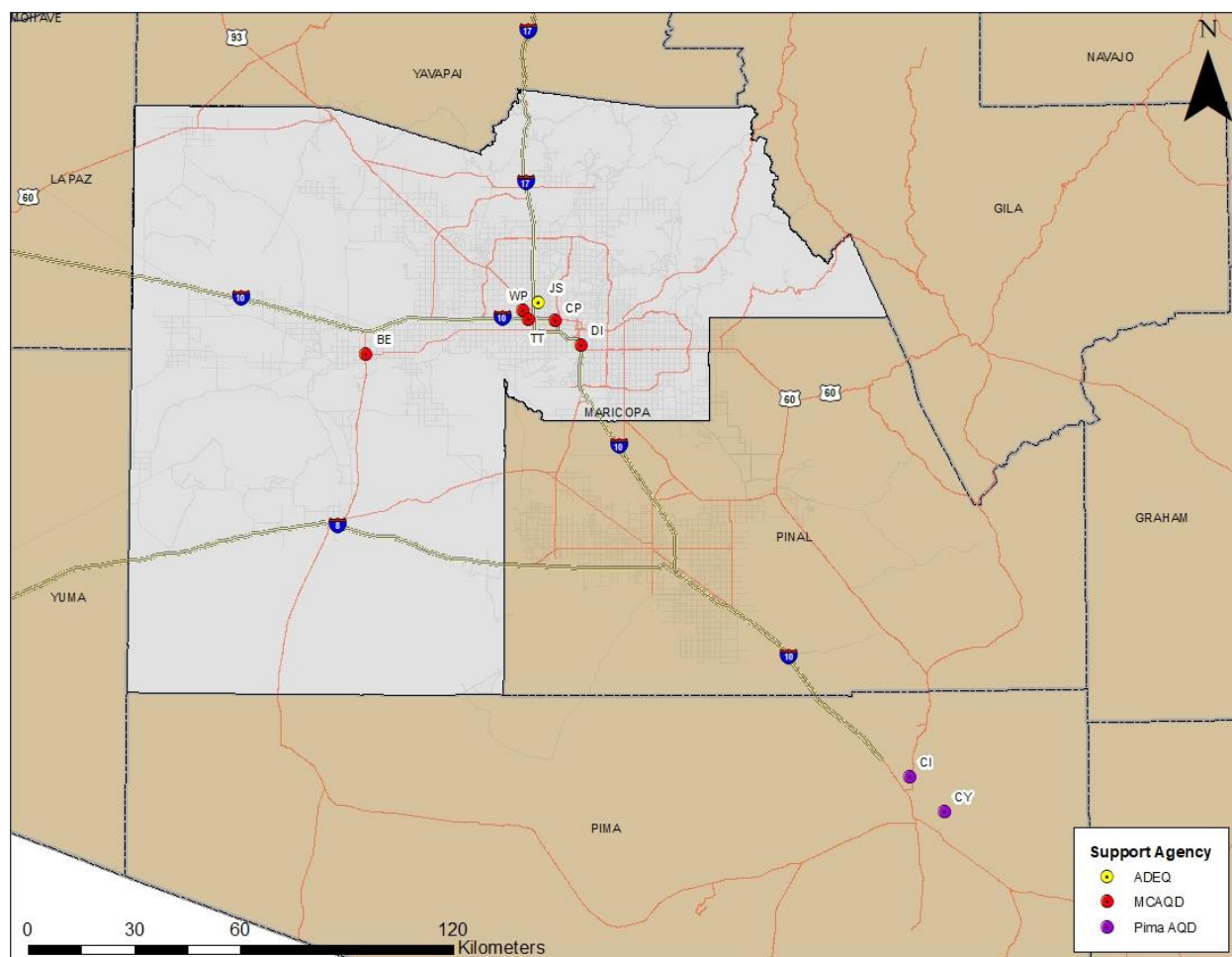
Maricopa County AQD Site	Acronym	Max. Correlation	Score
Buckeye	BE	0.108	7
Mesa	ME	0.343	6
West Chandler	WC	0.404	5
Diablo	DI	0.406	4
South Phoenix	SP	0.665	3
Central Phoenix	CP	0.703	2
West Phoenix	WP	0.771	1
Thirty-Third	TT	*	-

\*Not included in analysis due to limited operating time



**Figure 3.7.2.** Correlogram of CO monitoring sites.

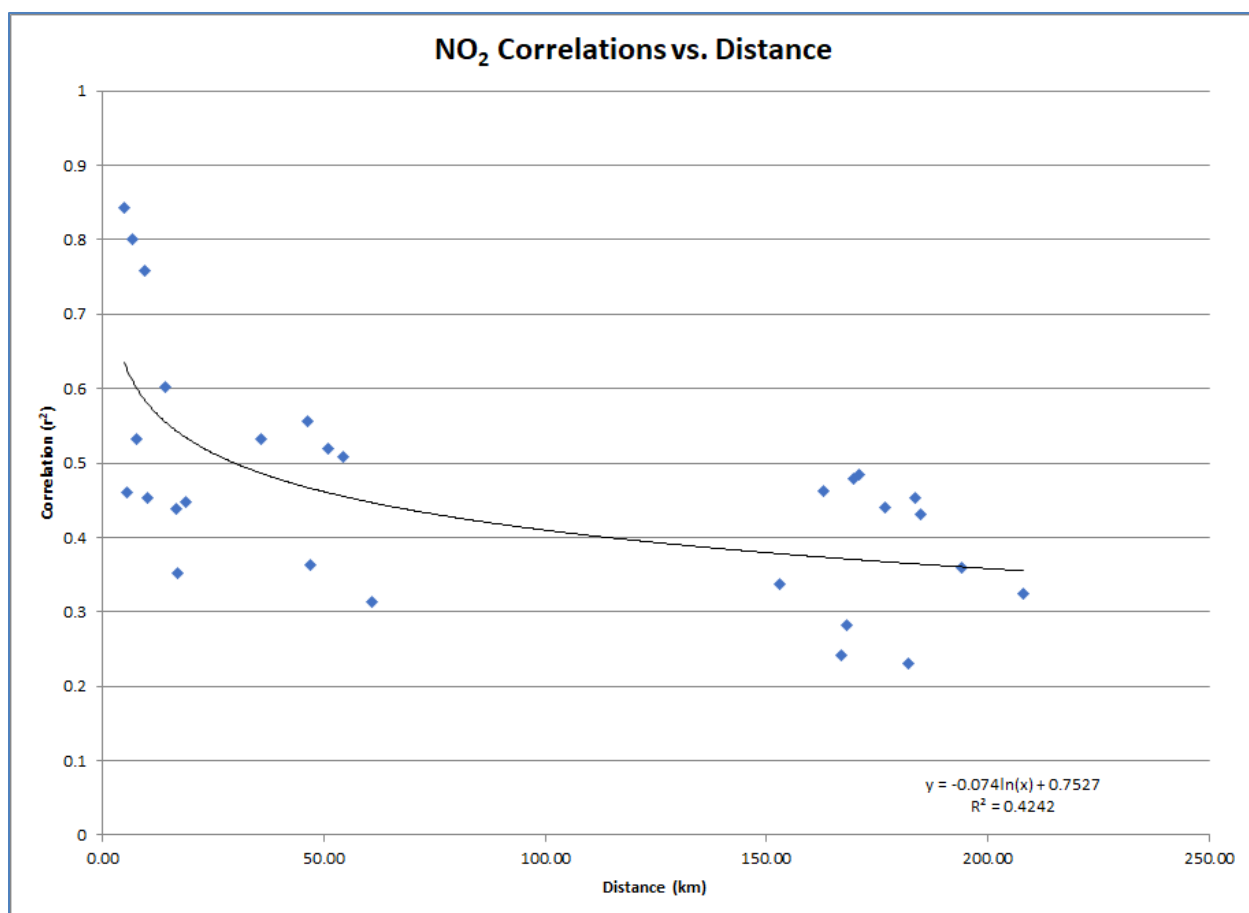
### 3.7.2 NO<sub>2</sub> Parameter Details



**Figure 3.7.3.** Map of NO<sub>2</sub> sites used for correlation analysis.

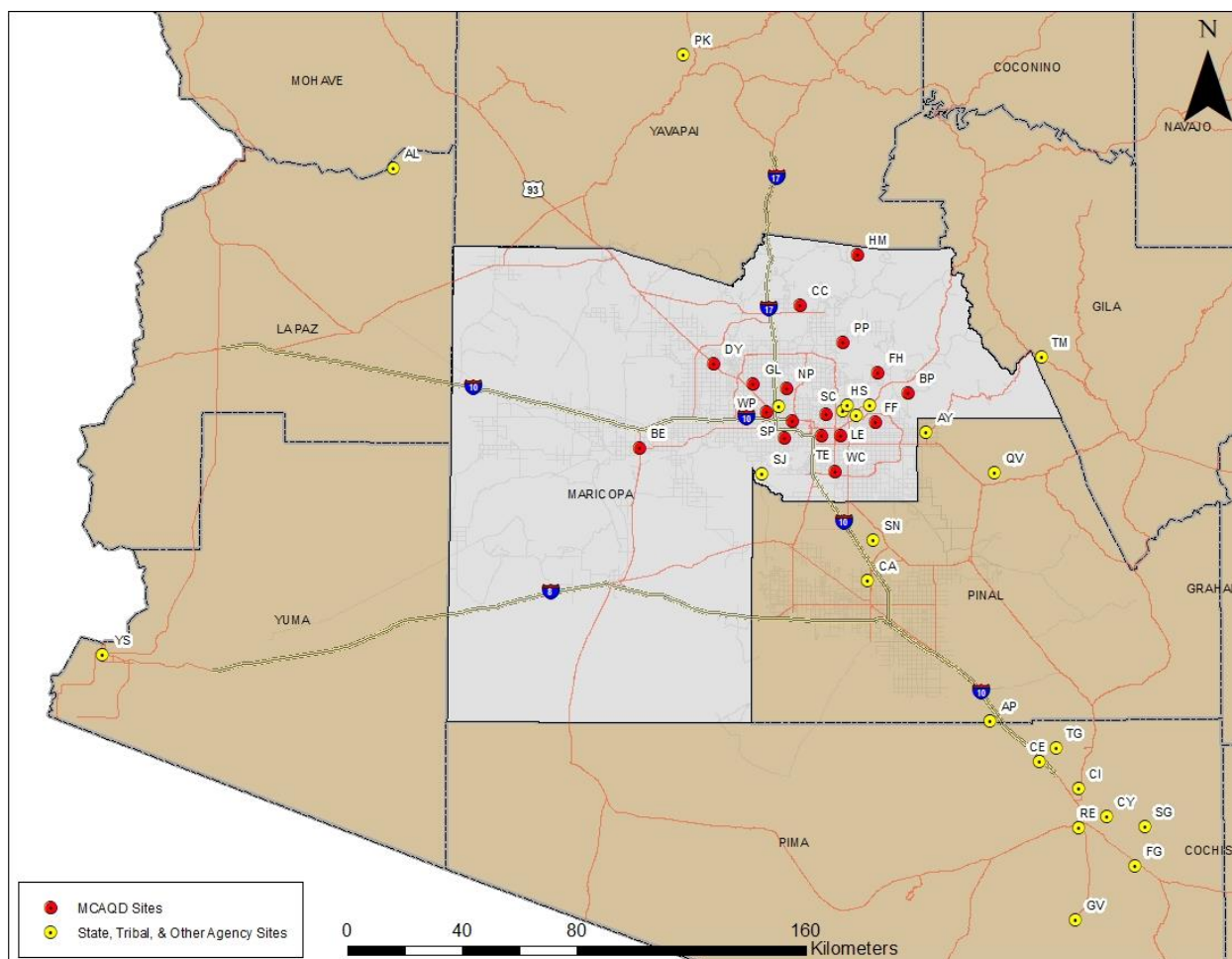
**Table 3.7.2.** NO<sub>2</sub> monitoring sites ordered and ranked by correlation.

Maricopa County AQD Site	Acronym	Max. Correlation	Score
Diablo	DI	0.45	5
Thirty-Third	TT	0.53	4
Buckeye	BE	0.56	3
Central Phoenix	CP	0.80	2
West Phoenix	WP	0.84	1



**Figure 3.7.4.** Correlogram of NO<sub>2</sub> monitoring sites.

### 3.7.3 O<sub>3</sub> Parameter Details

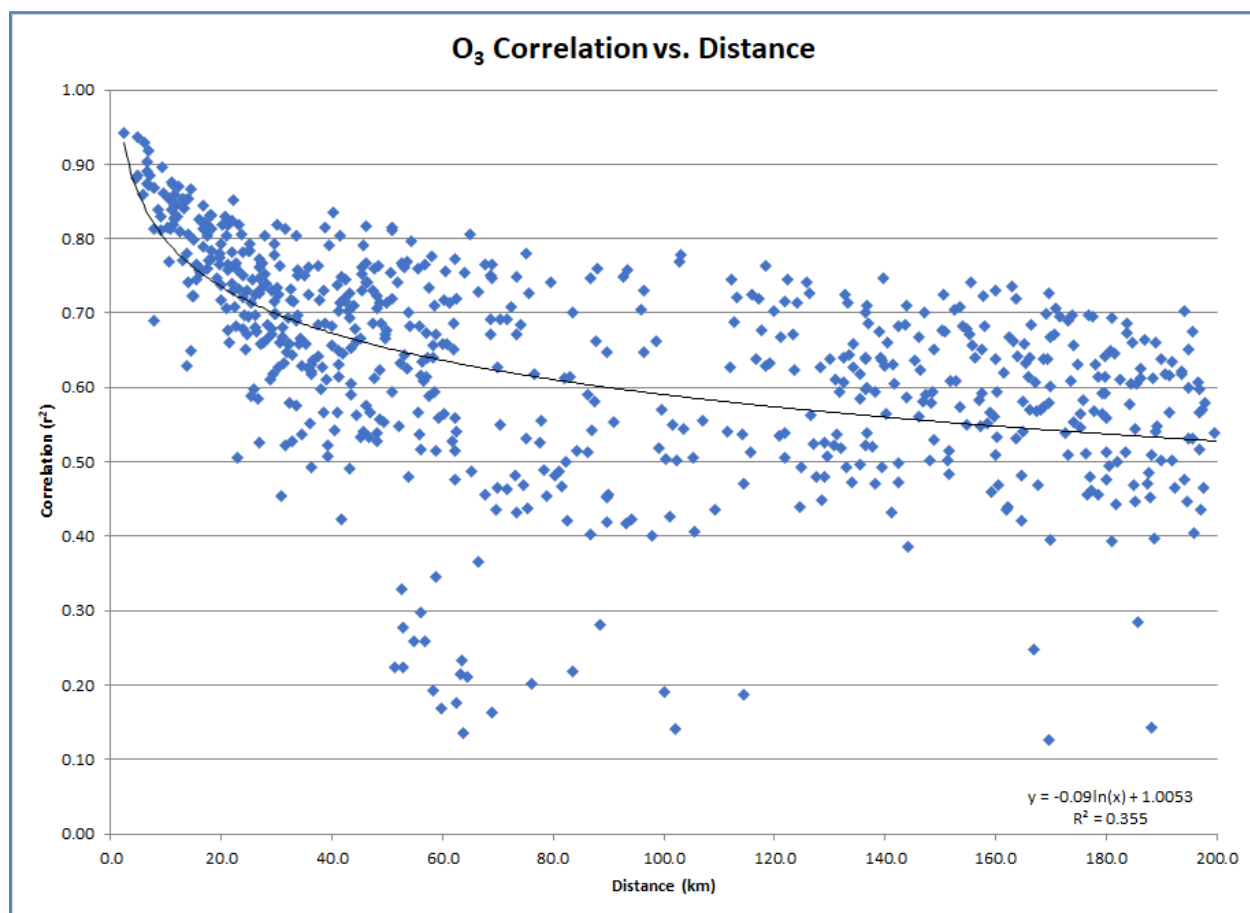


**Figure 3.7.5.** Map of O<sub>3</sub> sites used for analysis.

**Table 3.7.3.** O<sub>3</sub> monitoring sites ordered and ranked by correlation.

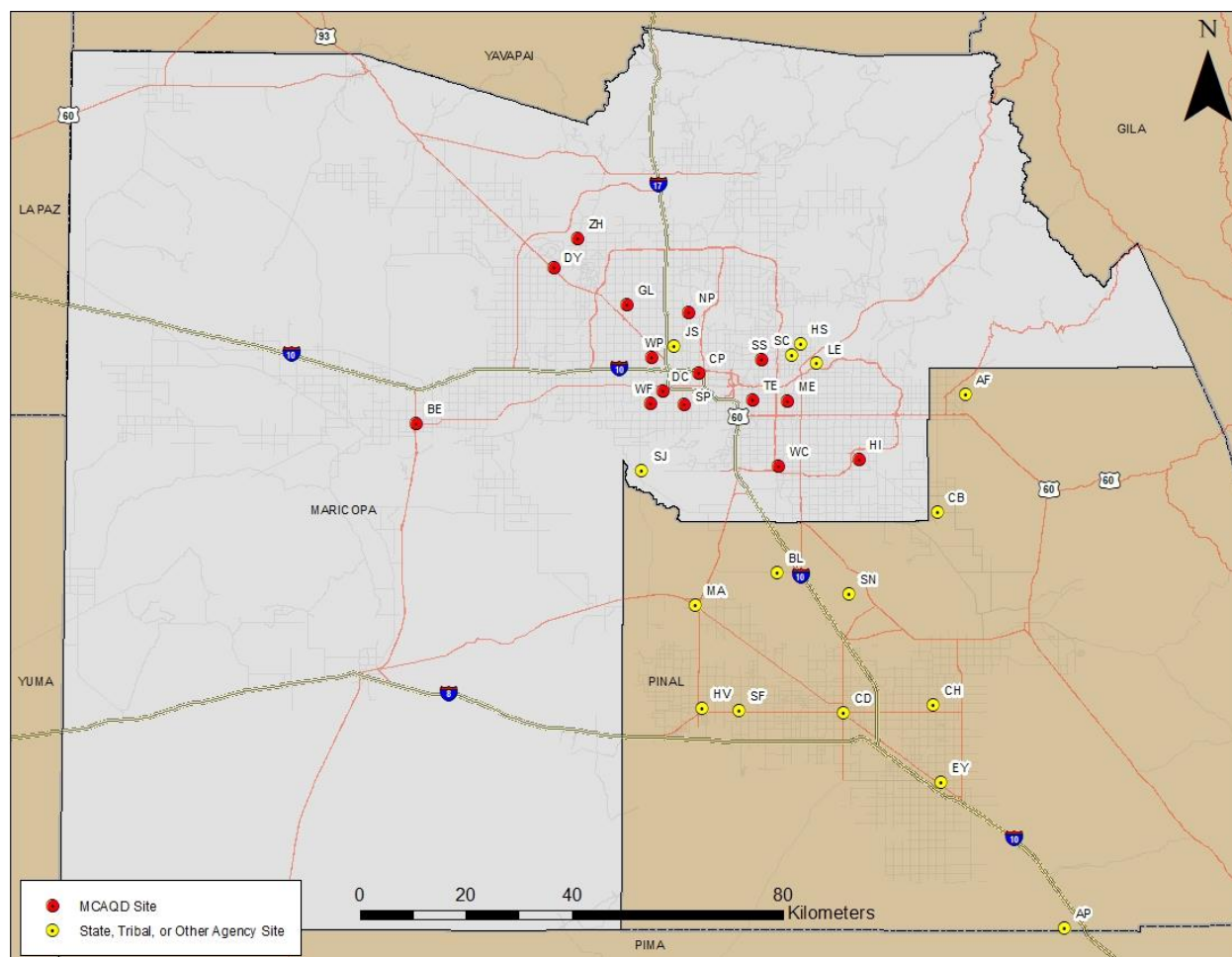
Maricopa County AQD Site	Acronym	Max. Correlation	Score
Humboldt Mountain	HM	0.527	16
Cave Creek	CC	0.774	15
Pinnacle Peak	PP	0.782	14
Blue Point	BP	0.807	13
Buckeye	BE	0.816	12
Dysart	DY	0.826	11
Fountain Hills	FH	0.830	10
West Chandler	WC	0.841	9
Glendale	GL	0.853	8
South Scottsdale	SS	0.871	7
North Phoenix	NP	0.872	6
Mesa	ME	0.874	5
Tempe	TE	0.874	5
Falcon Field	FF	0.891	4

South Phoenix	SP	0.904	3
Central Phoenix	CP	0.918	2
West Phoenix	WP	0.936	1



**Figure 3.7.6.** Correlogram of O<sub>3</sub> monitoring sites.

### 3.7.4 PM<sub>10</sub> Parameter Details

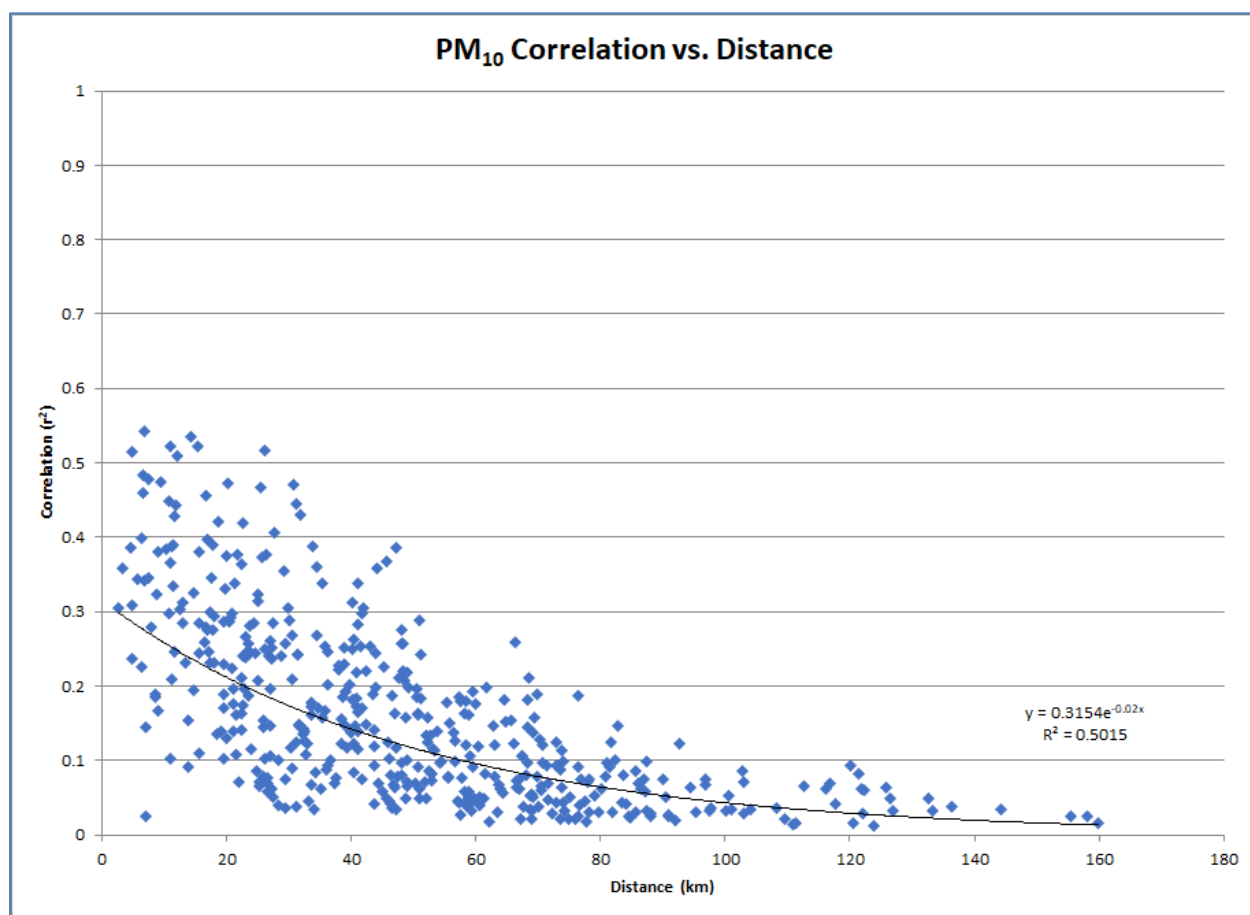


**Figure 3.7.7.** Map of PM<sub>10</sub> sites used for analysis.

**Table 3.7.4.** PM<sub>10</sub> monitoring sites ordered and ranked by maximum correlation.

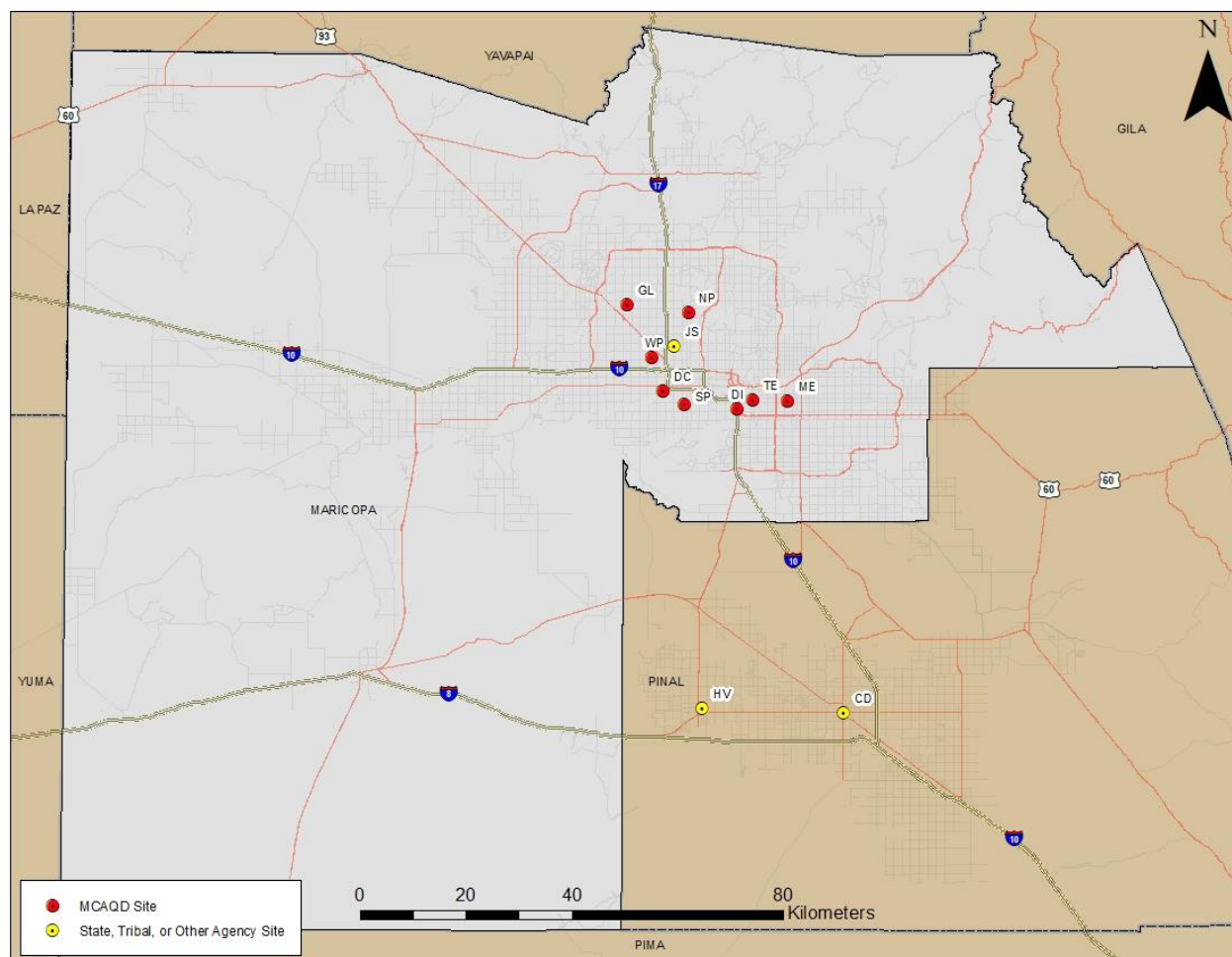
Maricopa County AQD Site	Acronym	Max. Correlation	Score
Buckeye	BE	0.125	11
Zuni Hills	ZH	0.144	10
West 43rd Avenue	WF	0.359	9
Mesa	ME	0.398	8
Tempe	TE	0.398	8
North Phoenix	NP	0.429	7
Dysart	DY	0.446	6
South Phoenix	SP	0.459	5
Durango Complex	DC	0.483	4
South Scottsdale	SS	0.517	3
Glendale	GL	0.522	2
West Phoenix	WP	0.522	2
West Chandler	WC	0.522	2
Higley	HI	0.522	2

Central Phoenix	CP	0.543	1
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**Figure 3.7.8.** Correlogram from PM<sub>10</sub> monitoring sites.

### 3.7.5 PM<sub>2.5</sub> Parameter Details

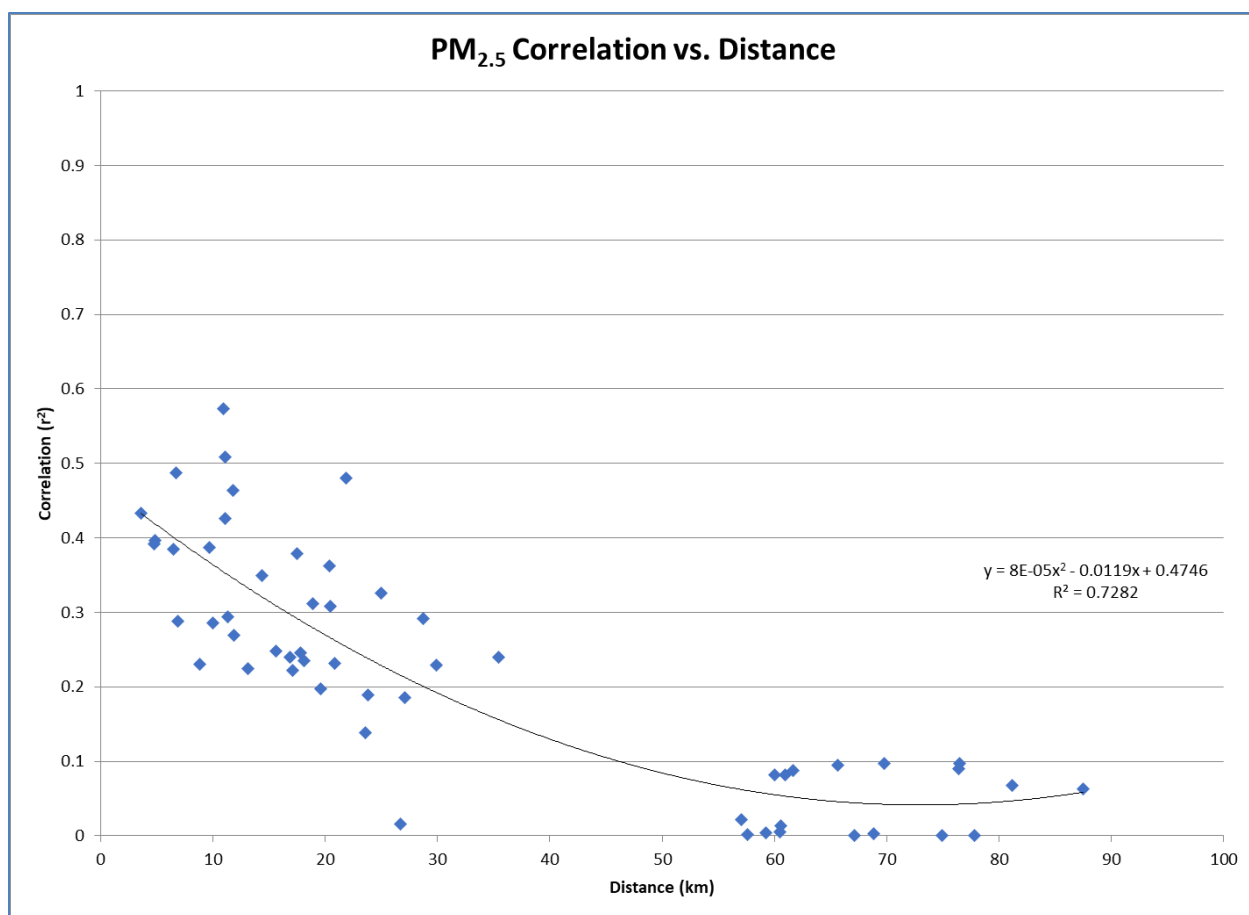


**Figure 3.7.9.** Map of PM<sub>2.5</sub> sites used for analysis.

**Table 3.7.5.** PM<sub>2.5</sub> monitoring sites ordered and ranked by correlation.

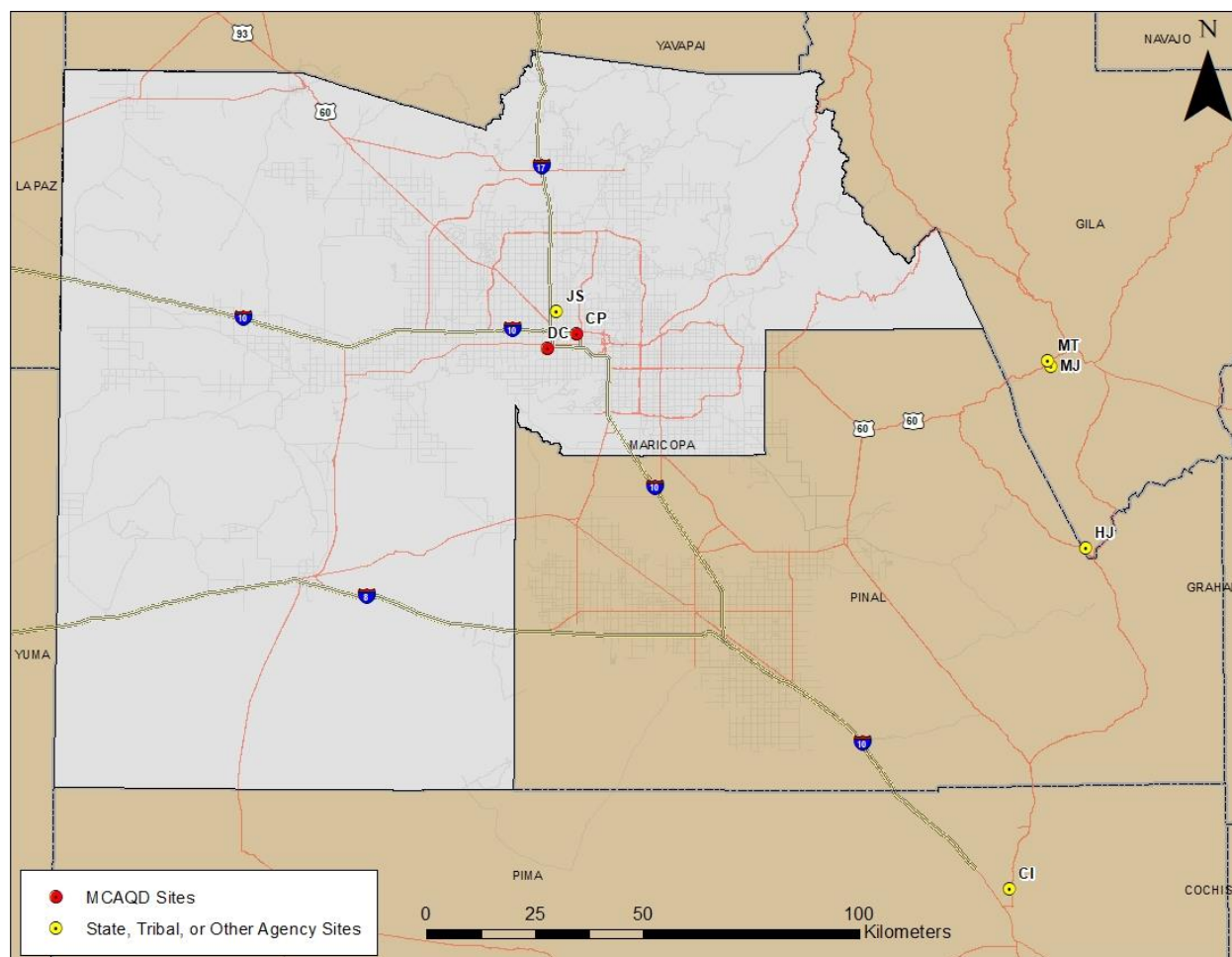
Maricopa County AQD Site	Acronym	Max. Correlation	Score
Mesa	ME	0.387	6
Diablo	DI	0.433	5
Tempe	TE	0.433	5
North Phoenix	NP	0.464	4
Durango Complex	DC	0.487	3
Glendale	GL	0.509	2
South Phoenix	SP	0.573	1
West Phoenix	WP	0.573	1
Thirty-Third	TT	*	-

\*Not included in analysis due to limited operating time



**Figure 3.7.10.** Correlogram of PM<sub>2.5</sub> monitoring sites.

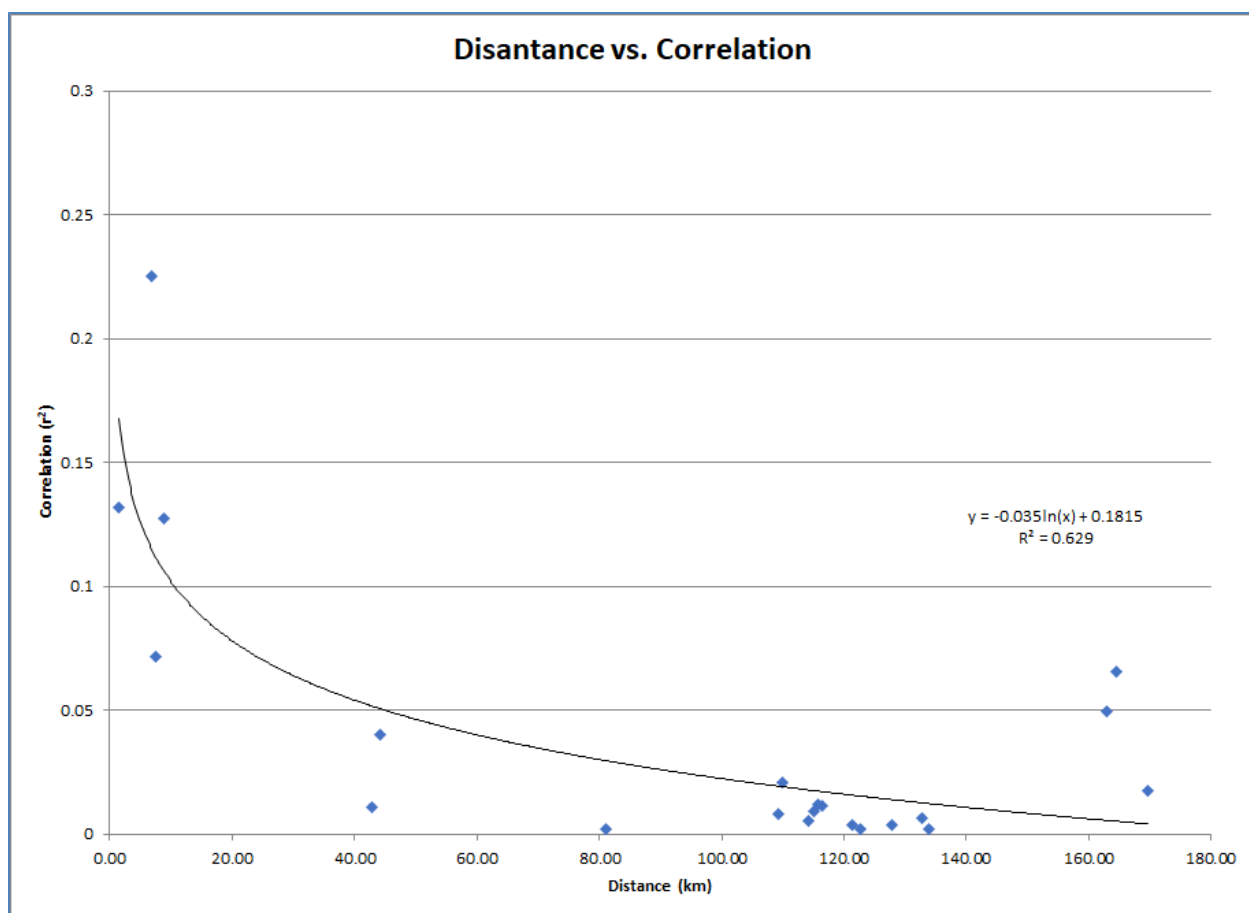
### 3.7.6 SO<sub>2</sub> Parameter Details



**Figure 3.7.11.** Map of SO<sub>2</sub> sites used for analysis.

**Table 3.7.6.** SO<sub>2</sub> monitoring sites ordered and ranked by correlation.

Maricopa County AQD Site	Acronym	Max. Correlation	Score
Durango Complex	DC	0.13	2
Central Phoenix	CP	0.22	1



**Figure 3.7.12.** Correlogram of SO<sub>2</sub> monitoring sites.

### 3.8 Analysis #8: Removal Bias

This analysis evaluates the contribution of each monitoring site to the creation of an interpolation map. For each pollutant parameter, a kriging interpolation map was created that incorporates all monitoring sites in that particular network. Each MCAQD monitoring site was then systematically removed from the dataset and the interpolation map was recreated. After removing a site, the difference between the actual value from the monitoring site and the predicted value from the interpolation map is recorded; this value is the “removal bias”. Sites are then ranked using the absolute value of the removal bias difference; a higher value equates a higher rank.

A five-year average was used for each pollutant parameter; thus, this analysis focuses on the long-term contributions that each site makes in determining the modeled pollution surface. The removal bias result would likely be different if a different temporal scale was used; however, this Assessment has other analysis techniques that focus on short-term time periods and episodic events.

Removal bias is a useful technique for noting redundancies in the monitoring network. Sites with a high removal bias difference are important for creating the interpolation map and their values add a unique perspective to the overall pollution surface. On the other hand, sites with a low removal bias difference could possibly be redundant with other sites, at least in the long-term temporal scale.

This analysis has disadvantages in that some parameters were not represented in counties adjacent to Maricopa County, i.e., carbon monoxide only has sites within the metropolitan areas of Maricopa and Pima Counties. A limitation of the technology used in creating interpolation maps is that the map is bounded by those outer-most monitoring sites which do not contribute fully to the creation of the map; this is known as the “edge effect”. Removing those sites will thus shrink the boundaries of the interpolation map and a removal bias cannot be obtained. Monitoring sites that are on the edge of the map were not assessed for their removal bias, though they were still used in the creation of the interpolation map for the other sites within that pollutant parameter’s network.

In each of the parameters below, a kriging interpolation map of the predicted pollution surface created from utilizing all network monitoring sites is shown. The accompanying tables show the results of the removal bias difference. Though additional interpolation maps are not displayed, there was a unique map created for every removed monitoring site within the parameter.

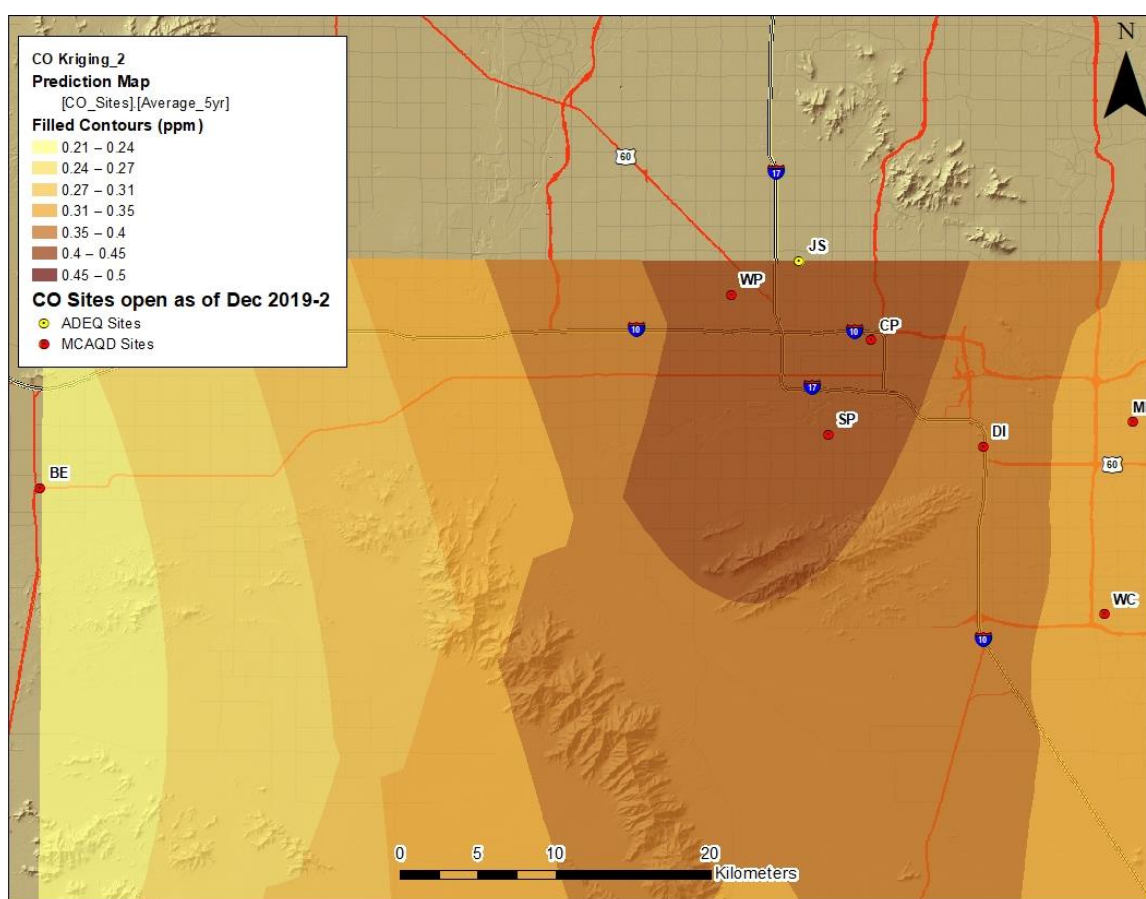
### 3.8.1 CO Parameter Details

**Table 3.8.1.** CO monitoring sites ordered and ranked by removal bias difference.

Maricopa County AQD Site	Average Concentration for 2015-2019 (ppm)	Removal Bias	Difference	Score
Mesa	0.279	0.381	0.102	6
West Phoenix	0.496	0.399	-0.097	5
Diablo	0.450	0.365	-0.085	4
South Phoenix	0.394	0.416	0.022	3
West Chandler	0.335	0.344	0.009	2
Central Phoenix	0.413	0.414	0.001	1
Buckeye	0.206	*	N/A	-
Thirty-Third	**	**	N/A	-

\* This site was on the edge of the edge of the kriging map and thus could not be used for an accurate removal bias. They were included in the kriging factoring of the other sites, however.

\*\*This site not included due to limited operating time



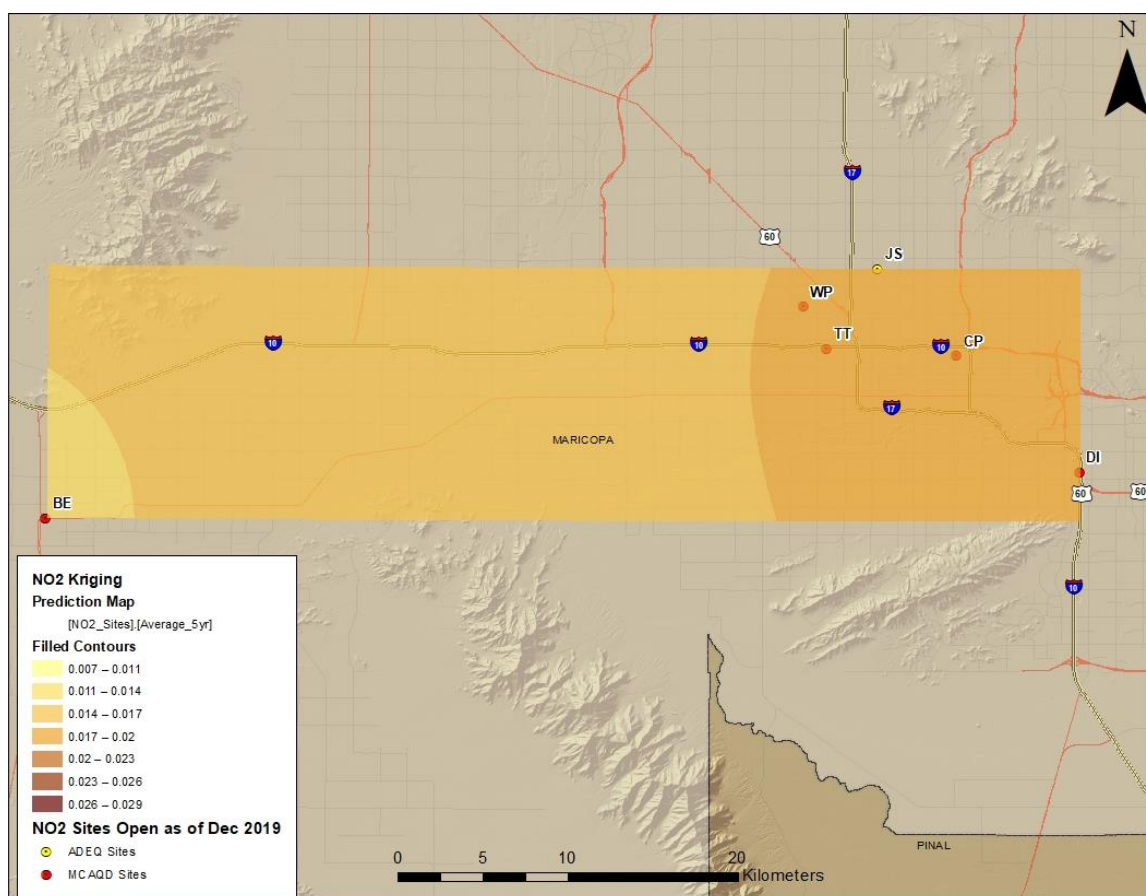
**Figure 3.8.1.** Kriging prediction map for CO.

### 3.8.2 NO<sub>2</sub> Parameter Details

**Table 3.8.2.** NO<sub>2</sub> monitoring sites ordered and ranked by removal bias difference.

Maricopa County AQD Site	Average Concentration for 2015-2019	Removal Bias	Difference	Score
Thirty-Third	29.1	16.0	-13.0	3
West Phoenix	16.0	19.2	3.3	2
Central Phoenix	17.3	17.5	0.1	1
Buckeye*	7.3	*	N/A	-
Diablo*	20.1	*	N/A	-

\* This site was on the edge of the edge of the kriging map and thus could not be used for an accurate removal bias. They were included in the kriging factoring of the other sites, however.

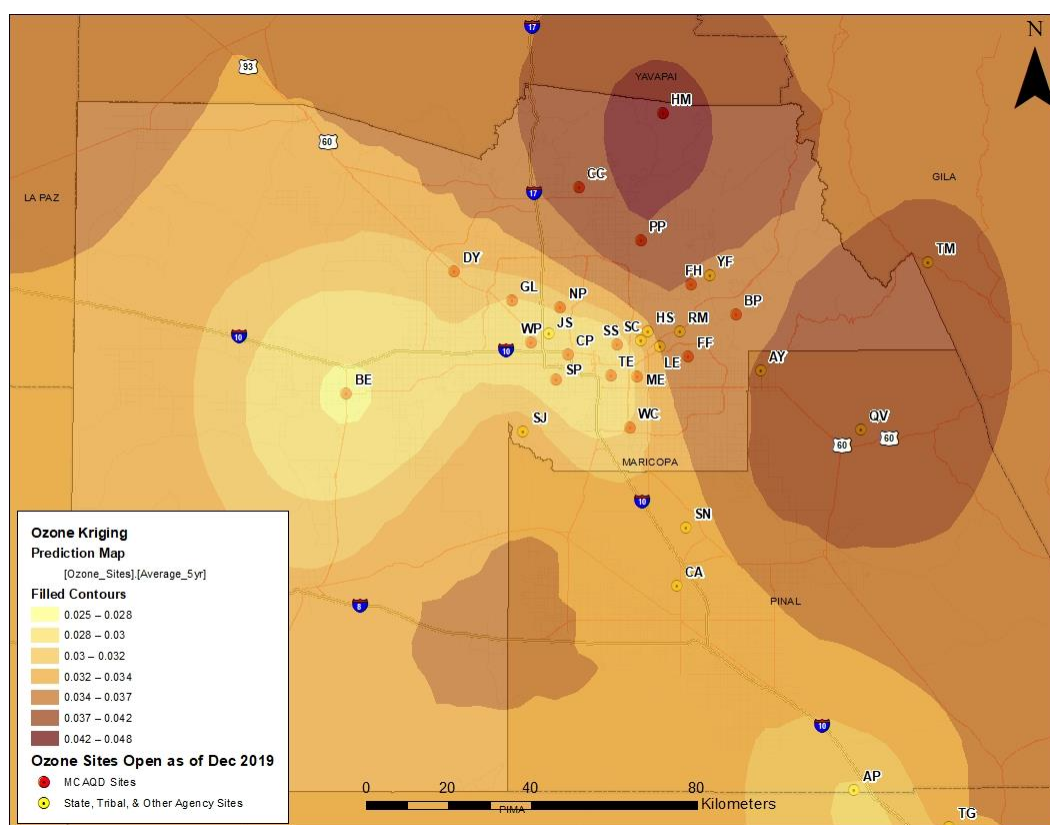


**Figure 3.8.2.** Kriging prediction map for NO<sub>2</sub>.

### 3.8.3 O<sub>3</sub> Parameter Details

**Table 3.8.3.** O<sub>3</sub> monitoring sites ordered and ranked by removal bias difference.

Maricopa County AQD Site	Average Concentration for 2015-2019	Removal Bias	Difference	Score
Humboldt Mountain	0.0483	0.0381	-0.0102	17
Buckeye	0.0266	0.0345	0.0079	16
Pinnacle Peak	0.0427	0.0370	-0.0056	15
Mesa	0.0335	0.0293	-0.0042	14
Dysart	0.0329	0.0303	-0.0026	13
Blue Point	0.0346	0.0371	0.0026	12
Glendale	0.0290	0.0311	0.0021	11
Tempe	0.0251	0.0270	0.0019	10
West Phoenix	0.0278	0.0296	0.0018	9
South Scottsdale	0.0280	0.0297	0.0017	8
Falcon Field	0.0369	0.0354	-0.0016	7
North Phoenix	0.0317	0.0305	-0.0012	6
Cave Creek	0.0407	0.0397	-0.0010	5
Central Phoenix	0.0278	0.0286	0.0008	4
Fountain Hills	0.0372	0.0366	-0.0006	3
South Phoenix	0.0285	0.0290	0.0005	2
West Chandler	0.0306	0.0303	-0.0003	1

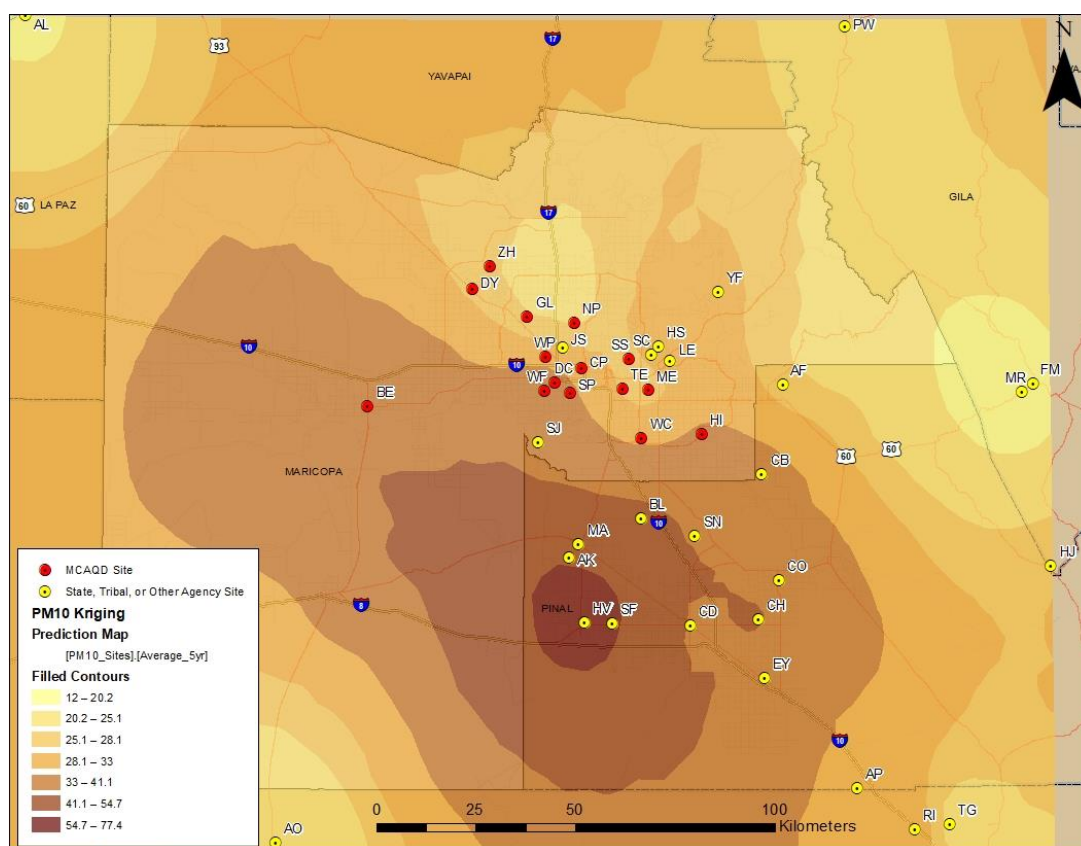


**Figure 3.8.3.** Kriging interpolation O<sub>3</sub> prediction map.

### 3.8.4 PM<sub>10</sub> Parameter Details

**Table 3.8.4.** PM<sub>10</sub> monitoring sites ordered and ranked by removal bias difference.

Maricopa County AQD Site	Average Concentration for 2015-2019	Removal Bias	Difference	Score
West 43 <sup>rd</sup> Avenue	51.10	33.43	-17.6636	15
Buckeye	41.65	31.31	-10.3359	14
North Phoenix	20.39	28.63	8.2438	13
Glendale	21.31	28.20	6.8892	12
Tempe	22.66	29.34	6.6830	11
Mesa	20.91	26.30	5.3854	10
Higley	36.93	32.29	-4.6454	9
South Phoenix	30.47	34.80	4.3331	8
Central Phoenix	33.75	29.57	-4.1829	7
West Phoenix	28.74	31.78	3.0416	6
Durango Complex	37.07	34.72	-2.3482	5
West Chandler	30.23	32.55	2.3171	4
South Scottsdale	27.60	28.06	0.4693	3
Dysart	27.74	27.43	-0.3152	2
Zuni Hills	25.82	25.95	0.1220	1



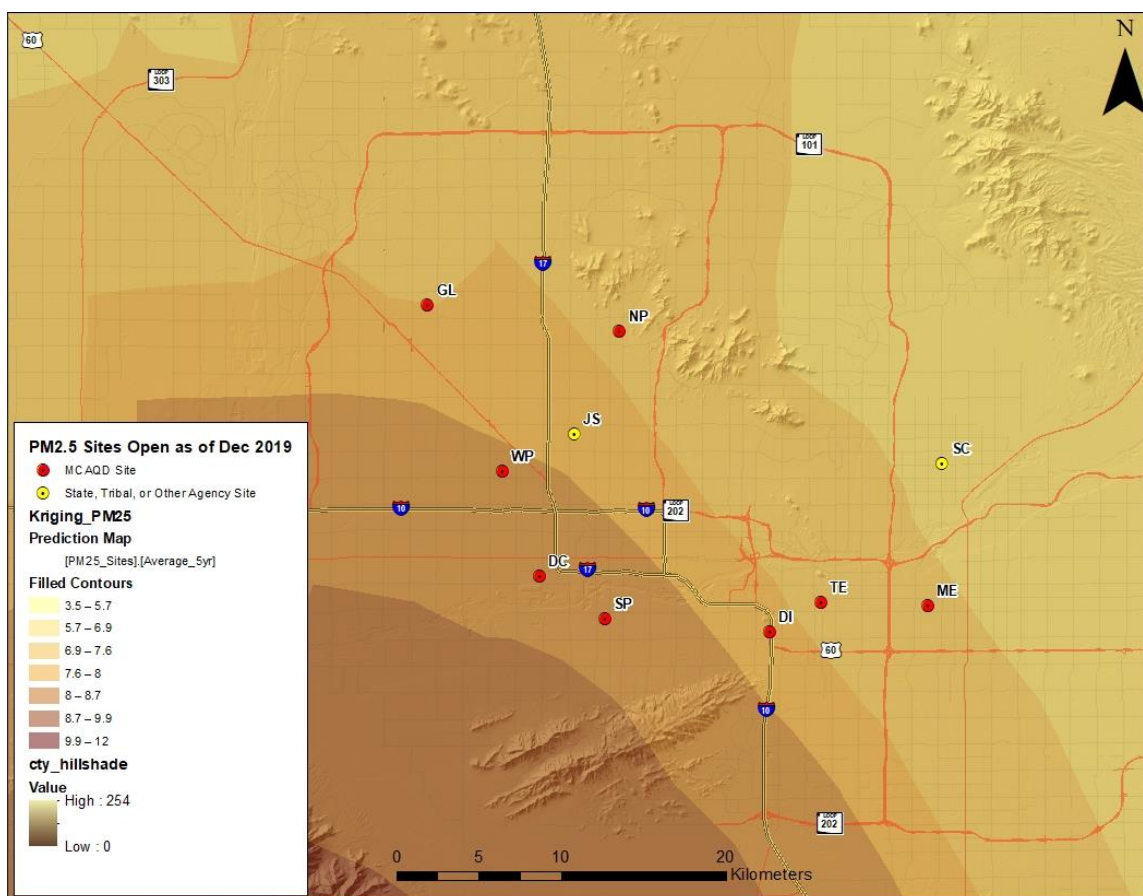
**Figure 3.8.4.** Kriging interpolation PM<sub>10</sub> prediction map.

### 3.8.5 PM<sub>2.5</sub> Parameter Details

**Table 3.8.5.** PM<sub>2.5</sub> monitoring sites ordered and ranked by removal bias difference.

Maricopa County AQD Site	Average Concentration for 2015-2019	Removal Bias	Difference	Score
West Phoenix	9.05	7.87	-1.18	8
Durango Complex	9.48	8.33	-1.15	7
Glendale	6.88	7.99	1.11	6
North Phoenix	6.87	7.66	0.79	5
Tempe	6.98	7.58	0.59	4
South Phoenix	8.73	8.31	-0.43	3
Diablo	7.92	7.70	-0.22	2
Mesa	6.88	7.02	0.14	1
Thirty-Third	*	*	*	-

\*Not included in analysis due to limited operating time



**Figure 3.8.5.** Kriging interpolation PM<sub>2.5</sub> prediction map.

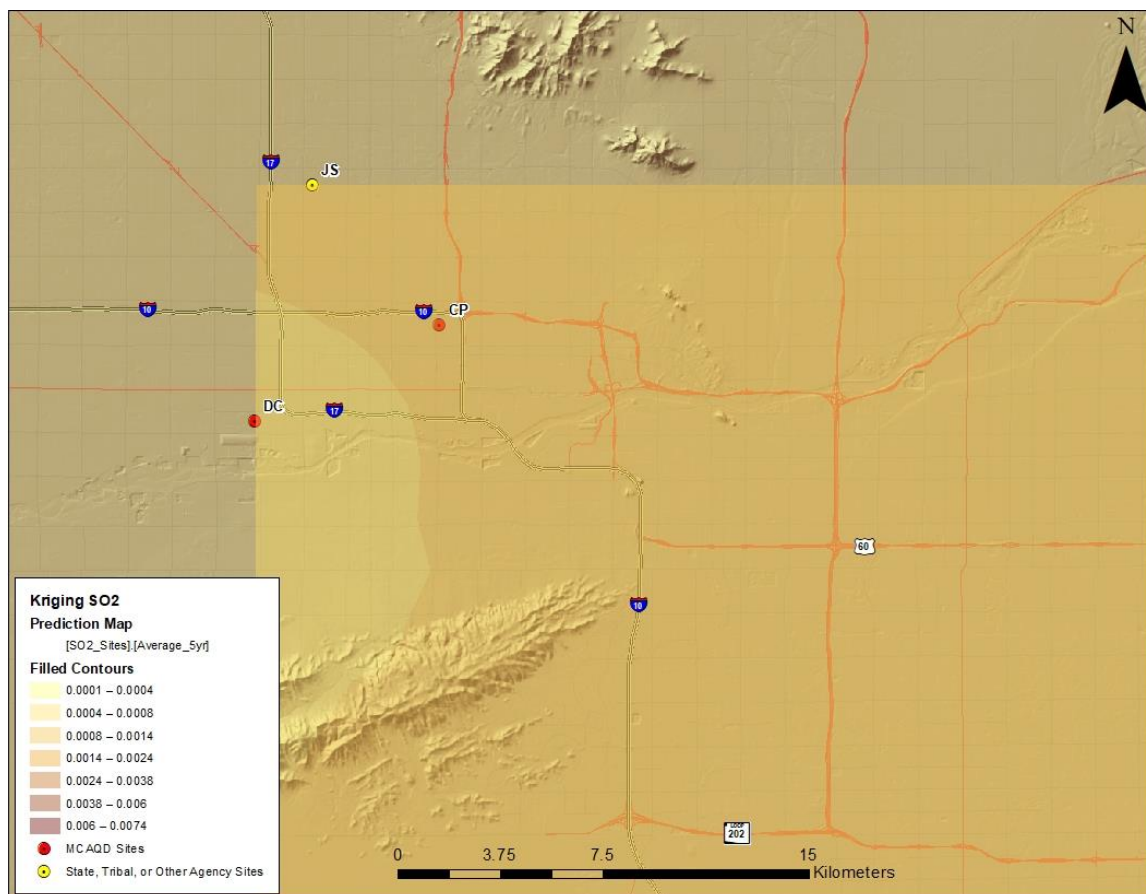
### 3.8.6 SO<sub>2</sub> Parameter Details

**Table 3.8.6.** SO<sub>2</sub> monitoring sites ordered and ranked by removal bias difference.

Maricopa County AQD Site	Average Concentration for 2015-2019	Removal Bias	Difference	Score
Central Phoenix	0.000804	0.000835	0.000031	*
Durango Complex	0.000757	**	N/A	-

\*Not scored since there is only one applicable site.

\*\* This site was on the edge of the edge of the kriging map and thus could not be used for an accurate removal bias. They were included in the kriging factoring of the other sites, however.



**Figure 3.8.6.** Kriging prediction map for SO<sub>2</sub>.

### 3.9 Analysis #9: Emissions Inventory

This analysis ranks sites based on their proximity to permitted point and area sources of pollution by giving weight to each monitor according to the density of the emissions in the surrounding area. The method used to determine the area of representation for each monitoring site was once again the use of Thiessen polygons (see Analysis #5: Area Served and Analysis #6: Population Served for more information about Thiessen polygons).

The MCAQD Planning and Analysis Division's Emissions Inventory section provided the 2004-2018 Annual Emissions Inventory reports, which list reported emissions from approximately 1,800 permitted sources within Maricopa County. The 2018 Annual Emissions Inventory was the latest one available at the time of this Assessment. Only permitted sources that were operating in the 2015-2019 time period were analyzed, but their latest available annual emissions data from 2004 to 2018 were used. The goal of this method was to include the latest emissions data from all active permitted sources, even those that were last surveyed up to 15 years previously. Major sources of emissions are surveyed annually, so data coming from older surveys tend to focus on smaller sources and it was assumed that their emissions stayed within the same order of magnitude even if significant time has passed since the last survey.

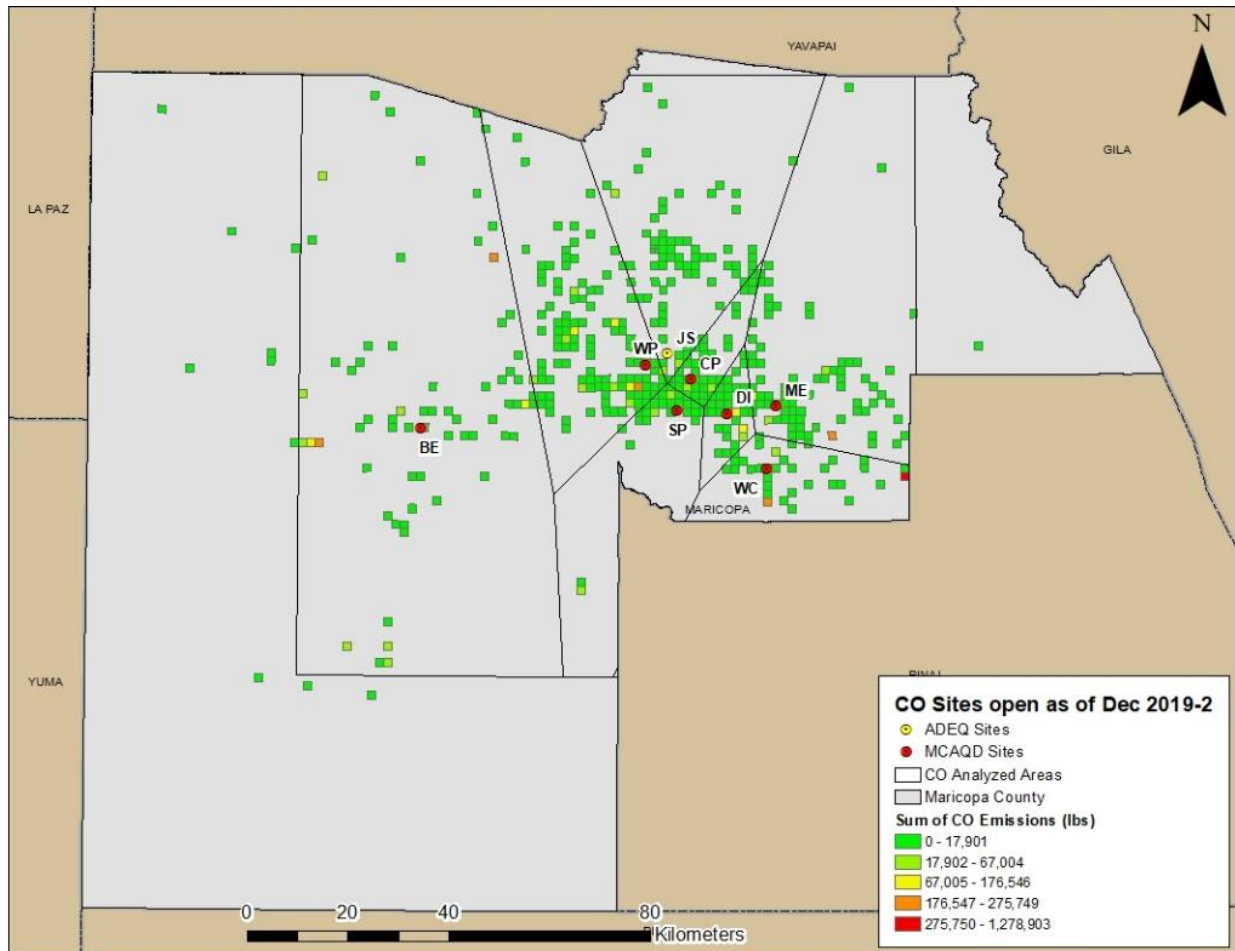
Permitted sources were spatially located within the inventory, and their emissions were then aggregated using the Public Land Survey System (PLSS), i.e., township, range, and section grid system, with each section being 1-mile (1.6 km) square in size (labeled emission-sections). Emissions were summed within each monitor's Thiessen polygon by selecting the emission-section centroids within that polygon. These results were normalized for emission density by dividing the emission sums by the Thiessen polygon area. Since the Annual Emissions Inventories only includes sources within the limits of Maricopa County, monitors and areas outside of the county were not used in analyzing emission densities. As in the Area and Population Served analyses (q.v.), the Thiessen polygons were clipped to the rectangular extent of the metropolitan areas (including the towns of Wickenburg and Gila Bend) of Maricopa County and then to the borders of the county itself. Polygons with higher emission densities were ranked higher.

This analysis has the advantage of being able to spatially locate emission sources in relation to existing monitors. The emission density normalization technique aids the analysis by taking weight away from the rural and urban fringe monitors that have large Thiessen polygons and thus emission sources that are farther away and have little effect on the monitor. There is a disadvantage in that this method, like the Area Served and Population Served methods, only accounts for spatial location and does not consider meteorology or landscape topography. However, the emission density normalization process does equalize the effect of spatial size and location and gives a fair representation of the point-source emission density that would affect each individual monitor. Another disadvantage of this analysis is that it does not consider non-permitted area sources from the emissions inventories; these area sources are an important component of an emissions inventory, but they lack the spatial data necessary to include them in this analysis. Mobile sources are also important component of emissions inventories, but these sources are addressed in the traffic counts analysis (q.v.).

The data from this method will also be used in Section 4 of this Assessment, as spatially-explicit point-source pollution data are very useful in determining monitoring weaknesses and locating new monitors.

### 3.9.1 CO Parameter Details

There were eight CO monitoring sites operating within Maricopa County at the end of 2019, though results shown are restricted to the seven sites belonging to MCAQD. Figure 3.9.1 shows surveyed emissions aggregated by township, range, and section (emission-sections), and the same emission-sections aggregated within each CO monitor's Thiessen polygon.



**Figure 3.9.1.** Permitted source annual CO emissions, aggregated by township, range, and section. CO network Thiessen polygons are also displayed.

Table 3.9.1 displays the sum of CO emissions within each monitor's Thiessen polygon. Other statistics, including the average emission value and the maximum emission-section are also displayed. The sum is then divided by the polygon area to create the emission density. Polygons with the highest density are scored the highest.

**Table 3.9.1.** CO monitoring sites aggregated and normalized by Thiessen polygon area.

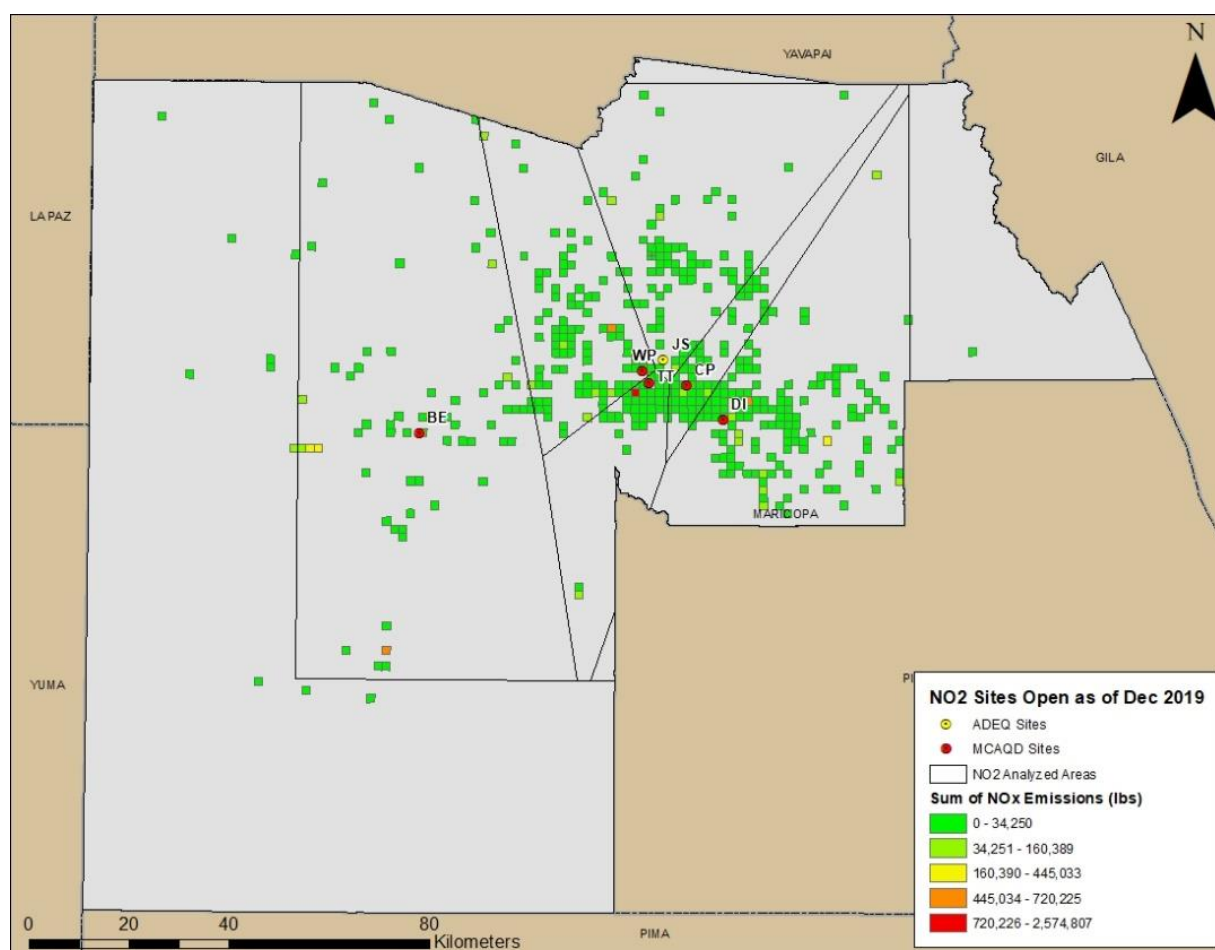
Site	Sum of CO Emissions (lbs)	Mean	Maximum emission-section	Area of Polygon (km <sup>2</sup> )	Density: Sum/Area (lbs/km <sup>2</sup> )	Score
West Chandler	1,618,170	50,568	1,278,903	572	2,829	7
Diablo	325,979	9,878	114,145	174	1,873	6
Central Phoenix	152,818	4,776	34,245	180	849	5
West Phoenix	1,087,793	9,800	233,844	1449	751	4
South Phoenix	223,464	9,311	58,763	837	267	3
Mesa	522,012	6,869	191,348	2,070	252	2
Buckeye	1,209,024	18,600	275,749	5,317	227	1
Dysart	*	*	*	*	*	-
Glendale	*	*	*	*	*	-
Greenwood	*	*	*	*	*	-
North Phoenix	*	*	*	*	*	-
South Scottsdale	*	*	*	*	*	-
Tempe	*	*	*	*	*	-
Thirty-Third	**	**	**	**	**	-

\*These CO sites were closed before December 2019 and were not included in the analysis.

\*\*This site not included due to limited operating time.

### 3.9.2 NO<sub>2</sub> Parameter Details

There were six NO<sub>2</sub> monitors operating within Maricopa County at the end of 2019, though results shown are restricted to the five sites belonging to MCAQD. Results are shown below.



**Figure 3.9.2.** Permitted source annual NO<sub>2</sub> emissions, aggregated by township, range, and section. NO<sub>2</sub> network Thiessen polygons are also displayed.

Table 3.9.2 displays the sum of NO<sub>2</sub> emissions in each monitor's Thiessen polygon. After normalizing for density, the monitoring sites are ranked in order of greatest density.

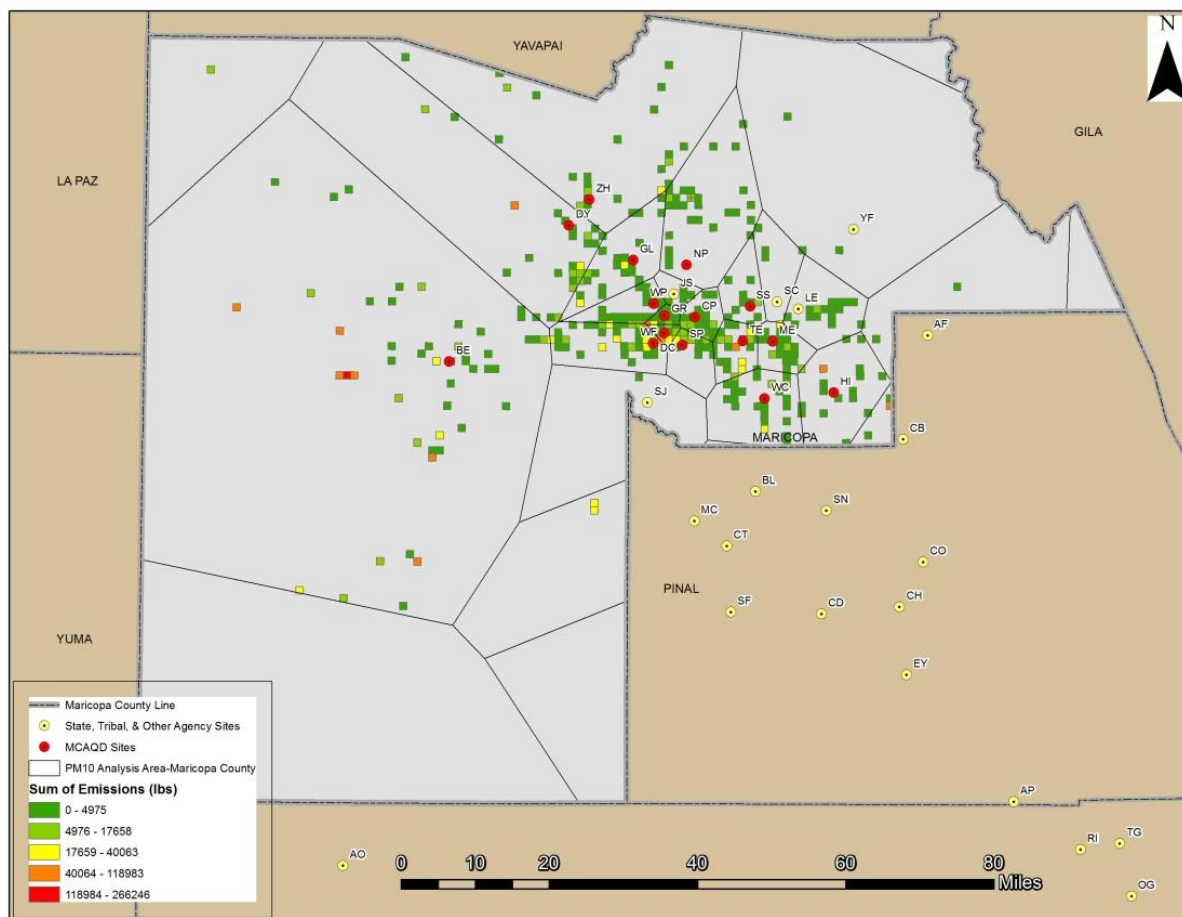
**Table 3.9.2.** NO<sub>2</sub> monitoring sites aggregated and normalized by Thiessen polygon area.

Site	Sum of NO <sub>2</sub> Emissions (lbs)	Mean	Maximum emission-section	Area of Polygon (km <sup>2</sup> )	Density: Sum/Area (lbs/km <sup>2</sup> )	Score
Thirty-third	2,945,832	81,829	2,574,807	769	3,831	5
West Phoenix	1,423,096	15,139	720,225	1,278	1,114	4
Diablo	2,231,058	16,650	564,885	2423	921	3
Central Phoenix	313,888	7,134	71,980	482	651	2
Buckeye	1,922,918	29,135	611,458	5,370	358	1
Greenwood	*	*	*	*	*	-

\*The Greenwood site was closed in June 2016 and was not included in the analysis.

### 3.9.3 PM<sub>10</sub> Parameter Details

There were 21 PM<sub>10</sub> monitors operating within Maricopa County at the end of 2019; these were operated by MCAQD, ADEQ, and tribal agencies. Of these, 15 were operated by MCAQD and only analysis results from these monitors are displayed in this section



**Figure 3.9.3.** Permitted source annual PM<sub>10</sub> emissions, aggregated by township, range, and section.

Table 3.9.3 displays the sum of PM<sub>10</sub> emissions in each monitor's Thiessen polygon. After normalizing for density, the monitoring sites are ranked in order of greatest density.

**Table 3.9.3.** PM<sub>10</sub> monitoring sites aggregated and normalized by Thiessen polygon area.

Site	Sum of PM <sub>10</sub> Emissions (lbs)	Mean	Maximum emission- section	Area of Polygon (km <sup>2</sup> )	Density: Sum/Area (lbs/km <sup>2</sup> )	Score
Durango Complex	129,916	11,811	48,505	29	4,480	15
West Chandler	853,317	30,476	717,629	298	2,863	14
West 43rd Ave.	482,116	13,030	155,156	215	2,242	13
Tempe	225,446	8,350	60,092	114	1,978	12
Mesa	119,263	5,679	44,498	101	1,181	11
South Phoenix	63,722	5,793	29,606	129	494	10
West Phoenix	51,128	2,435	24,163	104	492	9
Central Phoenix	40,848	1,634	10,276	86	475	8
Glendale	117,296	3,665	45,954	290	404	7
Higley	129,295	4,618	94,670	364	355	6
Buckeye	895,394	14,679	215,759	3,630	247	5
Dysart	336,503	6,349	121,537	1,541	218	4
North Phoenix	87,327	1,712	13,357	728	120	3
South Scottsdale	10,557	587	6,539	134	79	2
Zuni Hills	88,551	3,053	19,188	1,169	76	1
Greenwood	*	*	*	*	*	-

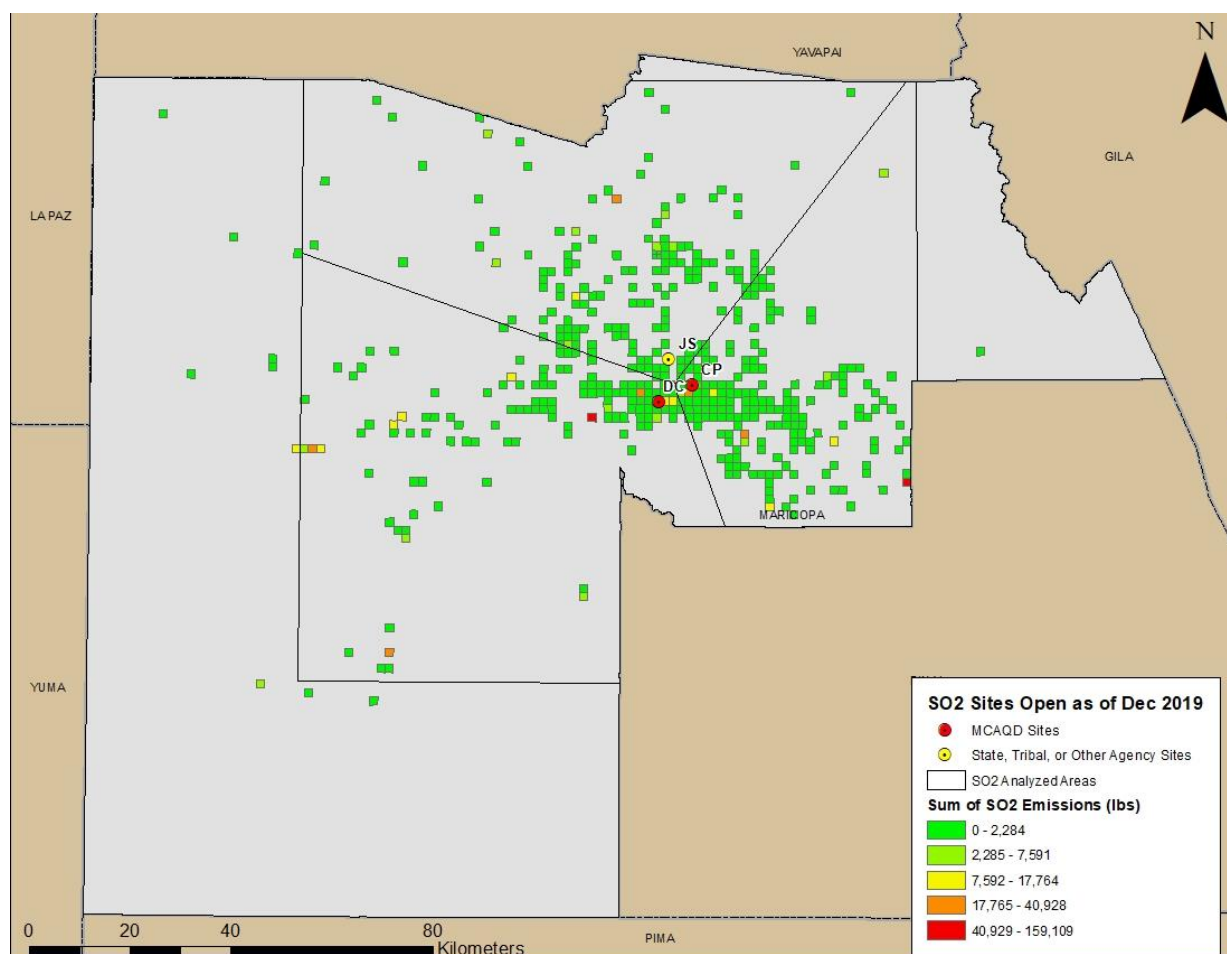
\*The Greenwood site was closed in June 2016 and was not included in the analysis.

### 3.9.4 PM<sub>2.5</sub> Parameter Details

PM<sub>2.5</sub> monitoring sites were not analyzed by this method as actual (not modeled) emissions inventory data for PM<sub>2.5</sub> does not exist.

### 3.9.5 SO<sub>2</sub> Parameter Details

There are only three SO<sub>2</sub> monitors within Maricopa, one at the ADEQ's Supersite and two operated by MCAQD at Central Phoenix and Durango Complex. The two MCAQD monitors were the only ones evaluated in this analysis.



**Figure 3.9.4.** Permitted source annual SO<sub>2</sub> emissions, aggregated by township, range, and section.

Table 3.9.5 displays the sum of SO<sub>2</sub> emissions in each monitor's Thiessen polygon. After normalizing for density, the monitoring sites are ranked in order of greatest density.

**Table 3.9.5.** SO<sub>2</sub> monitoring sites aggregated and normalized by Thiessen polygon area.

Site	Sum of SO <sub>2</sub> Emissions (lbs)	Mean	Maximum emission-section	Area of Polygon (km <sup>2</sup> )	Density: Sum/Area (lbs/km <sup>2</sup> )	Score
Central Phoenix	215,506	1,218	89,120	2,706	80	2
Durango Complex	376,864	3,039	159,109	5,111	74	1

### 3.9.6 Volatile Organic Compounds and Ozone Details

Tropospheric O<sub>3</sub> is a secondary pollutant, meaning that it is not directly emitted, but rather results from a chemical reaction between the sun and precursor compounds such as volatile organic compounds (VOCs) and nitrogen oxides (NO<sub>x</sub>). Furthermore, although O<sub>3</sub> needs NO<sub>x</sub> in its formation reaction, it is also scavenged, or destroyed, by NO<sub>x</sub> in the atmosphere. Because of these chemical dynamics, O<sub>3</sub> concentrations follow much different patterns than other primary pollutants. In the short-term, several hours or less, O<sub>3</sub> will begin forming near its precursor sources and increase in concentrations as the plume moves downwind during the afternoon and has more time to react. At night, with the photochemical reaction stopped, O<sub>3</sub> concentrations within the urban area will decrease as NO<sub>x</sub> compounds in the area scavenge them. However, outside of the urban areas, where NO<sub>x</sub> concentrations are low, O<sub>3</sub> will persist in the environment and can last for weeks before dissipation or deposition. These dynamics often causes O<sub>3</sub> concentrations to be much higher in the rural areas downwind of an urban area, especially when viewing concentrations averaged over long temporal periods. Figure 3.9.5 shows this relationship by displaying a prediction map of O<sub>3</sub> values in relation to its VOC precursor sources generated by using the 2015-2019 annual average of O<sub>3</sub>.

Because of these dynamics, the methodology of ranking O<sub>3</sub> monitors in order of the emission densities of VOC point-sources is not totally valid. It is still practical to use the method established with the other primary pollutants, as the short-term O<sub>3</sub> levels are still high in the areas surrounding the precursor sources, but another method of rank involving the long-term averages also needs to be adopted.

Table 3.9.6 shows this additional ranking system, a kriging interpolation map created with the 2015-2019 predicted O<sub>3</sub> levels. The map was converted into a raster surface and then statistics were generated for each O<sub>3</sub> monitor's Thiessen polygon. Ranks were based on the polygon's mean long-term O<sub>3</sub> concentration, with the highest concentration ranking higher. Both ranking systems will be combined and weighed together when evaluating O<sub>3</sub> monitoring sites.

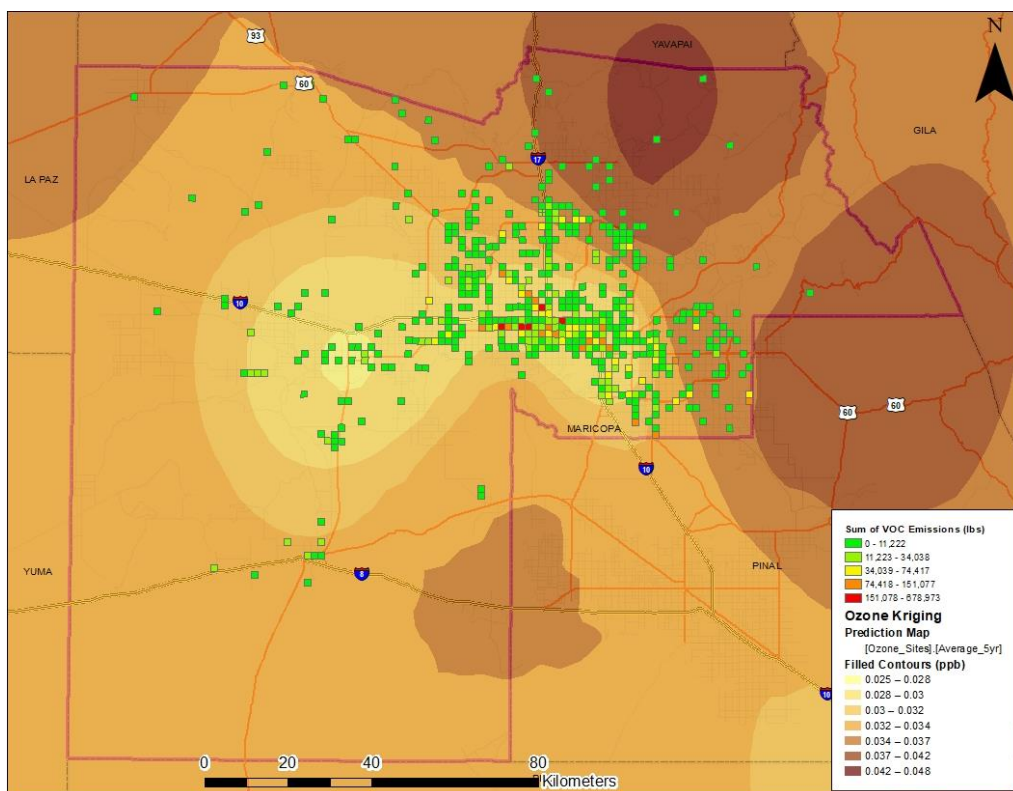


Figure 3.9.5. 2015-2019 predicted O<sub>3</sub> levels in relation to VOC precursor point-sources.

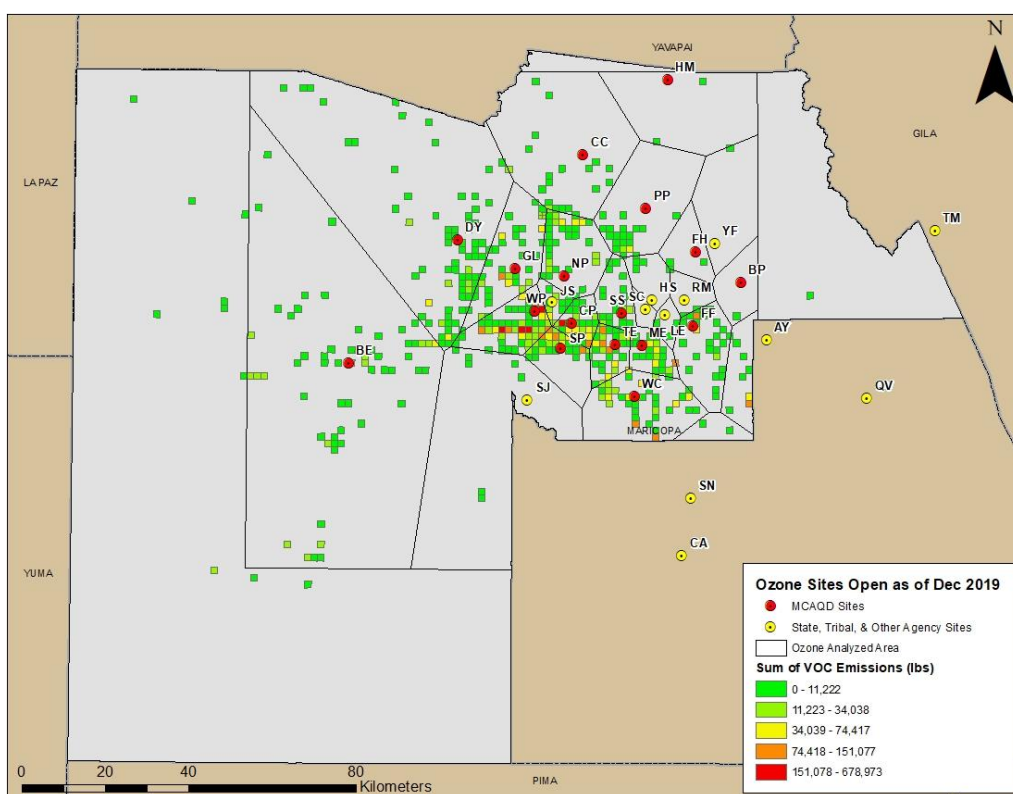


Figure 3.9.6. Permitted source annual VOC emissions, aggregated by township, range, & section.

Table 3.9.6 displays the total VOC emissions based on the location of emission-sections within the Thiessen polygon sector of the map. There were a total of 24 O<sub>3</sub> monitors within Maricopa County at the end of 2019, though only results from the 17 monitors operated by MCAQD are displayed in this analysis. The other O<sub>3</sub> monitors in Maricopa County were operated by the ADEQ, Fort McDowell Yavapai Nation, Gila River Indian Community, and the Salt River Pima-Maricopa Indian Community.

**Table 3.9.6.** VOC emissions aggregated and normalized by O<sub>3</sub> monitoring site Thiessen polygon area.

Site	Sum of VOC Emissions (lbs)	Mean	Maximum emission-section	Area of Polygon (km <sup>2</sup> )	Density: Sum/Area (lbs/km <sup>2</sup> )	Score
West Phoenix	2,760,016	56,327	678,973	217	12,719	17
Central Phoenix	760,502	29,250	295,509	87	8,741	16
Tempe	700,315	25,938	120,304	114	6,143	15
South Phoenix	513,944	22,345	132,610	171	3,006	14
Mesa	305,321	13,878	78,915	106	2,880	13
West Chandler	686,016	19,056	128,986	394	1,741	12
Glendale	499,343	12,804	151,077	345	1,447	11
North Phoenix	338,467	11,282	55,445	263	1,287	10
Falcon Field	234,823	9,393	109,884	260	903	9
South Scottsdale	73,428	3,497	19,418	129	569	8
Pinnacle Peak	106,429	5,321	55,148	467	228	7
Dysart	317,969	4,478	55,970	2,159	147	6
Buckeye	353,546	6,096	50,153	3,646	97	5
Cave Creek	67,830	3,391	17,974	899	75	4
Fountain Hills	7,726	3,863	7,520	139	56	3
Humboldt Mountain	786	393	768	588	1	2
Blue Point	33	17	25	148	0.2	1
Rio Verde	*	*	*	*	*	-

\*The Rio Verde site was closed in October 2017 and was not included in the analysis.

Table 3.9.7 displays the predicted O<sub>3</sub> levels computed from a kriging interpolation from the O<sub>3</sub> monitoring locations. The kriging interpolation was based off of a 5-year average O<sub>3</sub> concentration measured from the O<sub>3</sub> network. The predicted O<sub>3</sub> is calculated within each monitor's Thiessen polygon sector and the mean concentration is used to rank the sites. The ranking from mean predicted O<sub>3</sub> will also be used when weighing O<sub>3</sub> monitors with the emissions inventory analysis.

**Table 3.9.7.** O<sub>3</sub> monitoring sites ranked by mean predicted O<sub>3</sub> concentrations.

Site	Predicted O3 concentration (ppb)			Area of Polygon (km <sup>2</sup> )	Score
	Minimum	Maximum	Mean		
Humboldt Mountain	39.61	44.83	42.48	588	17
Pinnacle Peak	35.06	42.87	40.21	467	16
Cave Creek	34.95	42.83	38.56	899	15
Fountain Hills	36.00	39.63	37.52	139	14
Blue Point	35.56	36.73	36.04	148	13
Falcon Field	34.21	36.66	35.87	260	12

North Phoenix	29.34	36.58	32.87	263	11
Dysart	29.57	35.31	32.72	2,159	10
Mesa	28.91	34.10	31.76	106	9
West Chandler	28.88	34.94	31.70	394	8
Glendale	29.40	35.09	31.54	345	7
Buckeye	27.40	33.94	30.59	3,646	6
South Scottsdale	27.81	34.86	30.58	129	5
West Phoenix	28.61	30.60	29.60	217	4
South Phoenix	27.99	30.79	29.43	171	3
Central Phoenix	27.76	29.63	28.40	87	2
Tempe	27.05	29.33	27.96	114	1
Rio Verde	*	*	*	*	-

\*The Rio Verde site was closed in October 2017 and was not included in the analysis.

### 3.10 Analysis #10: Traffic Counts

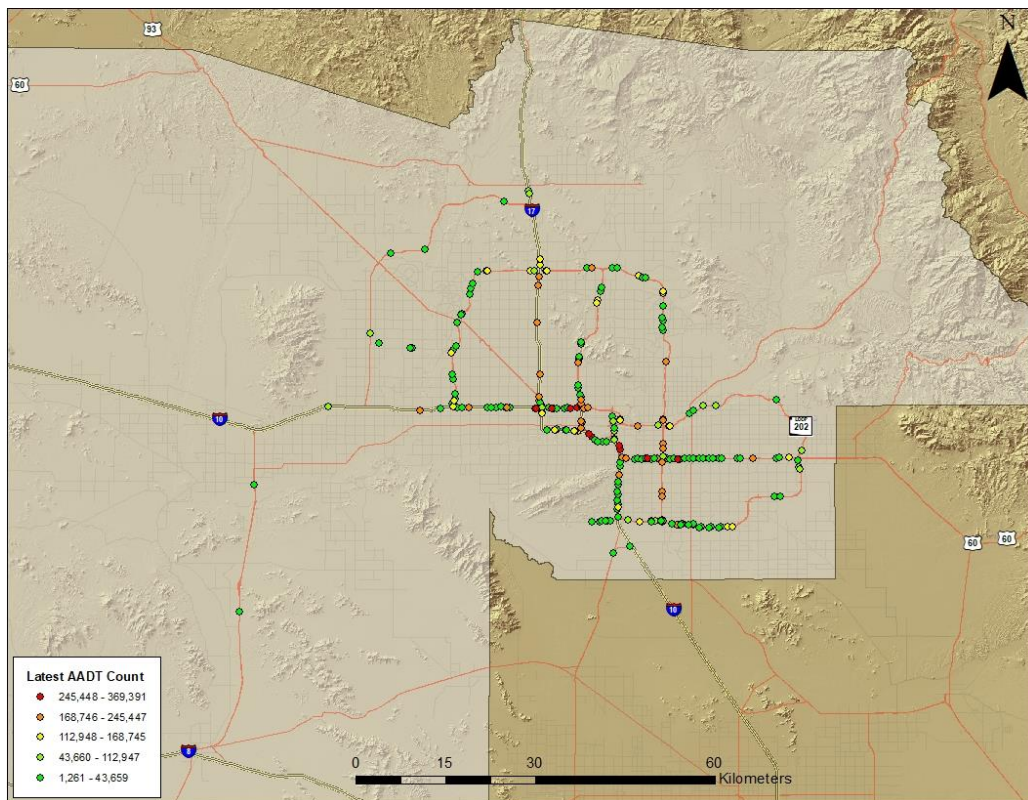
Permitted point and area source emissions only account for a portion of the pollution emission sources within an area, with other major sources being transportation. This analysis evaluates the mobile source emissions within the influence of a monitoring site; these data, along with permitted source data from the prior Emissions Inventory method, are used to derive the total effect of emissions within each site's Thiessen polygon.

Emissions from mobile sources can vary greatly; factors which can affect the amount of pollution released include road type (fast-moving vehicles on a highway generally emit less pollution per kilometer than vehicles on arterial roads and collectors), vehicle type (e.g. diesel vs. gasoline powered vehicles), traffic congestion, age and size of vehicles, etc. Ideally, a method which attempts to account for traffic emissions would account for all of these variables in a model which would give high spatial detail to mobile sources of pollution. Such traffic modeling is outside of the scope of this Assessment, instead, traffic count and road density will be used as a proxy to approximate the spatial variability of mobile source pollution.

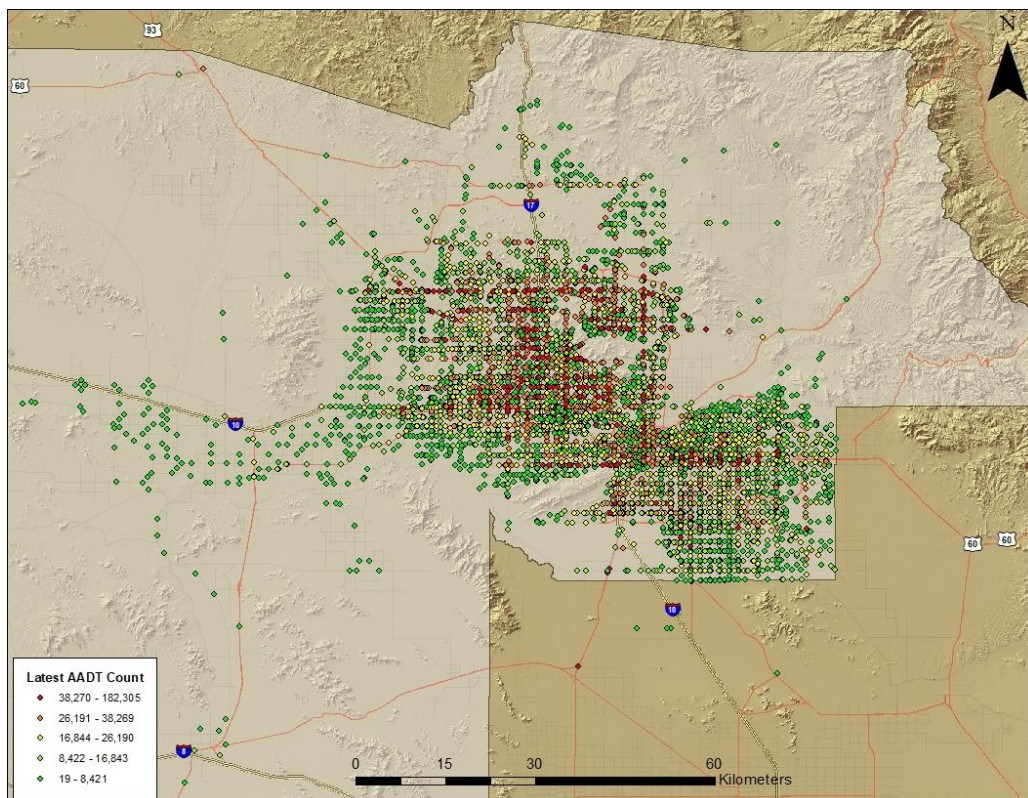
The latest annual average daily traffic (AADT) counts for Maricopa County were obtained from the Maricopa Association of Government's (MAG) Transportation Data Management System website. MAG in turn collects these counts from various state, county and municipal agencies. The dataset includes counts for highways, arterial, collector, and local (surface) roads with comprehensive sample location coverage. The latest count between 2002-2019 was used, though the majority of the 7,006 count locations were sampled in 2018-2019. However, it is difficult to ascertain if AADT sample locations include all roads with the same density and it is likely that additional new roads were not sampled. To normalize these data for evaluation, both the AADT and the length of roads within each monitor's Thiessen polygon were selected. These were then divided by the area of the polygon to determine the traffic and road density. The densities are then scored and averaged together to obtain the rank for each polygon.

Figures 3.10.1 and 3.10.2 illustrate the traffic count sample locations for highways and surface roads, respectively. The map is color coded to note the areas of highest traffic count.

The following sub-sections display traffic count information for the various parameters. The information displayed for each site is based upon that site's Thiessen polygon (See section 3.5., Analysis #5, for information and maps of the Thiessen polygons). After the traffic and road densities were found, they were averaged together and this average score was used to rank each site in order of impact from traffic emissions.



**Figure 3.10.1.** Annual average daily traffic (AADT) counts on Maricopa County highways.



**Figure 3.10.2.** AADT counts on Maricopa County arterial, collector, and local roads.

### 3.10.1 CO Parameter Details

**Table 3.10.1a.** CO monitoring sites Annual Average Daily Traffic (AADT) statistics.

Site	Sum of AADT Counts		Area of Thiessen Polygon (km <sup>2</sup> )	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/Area)
	Highway	Surface				
Buckeye	224,198	1,142,251	5,317	5,034,182	257.0	946.8
Central Phoenix	3,137,966	10,810,106	180	1,593,550	77,489.3	8,853.1
Diablo	3,247,994	10,410,347	174	1,383,799	78,496.2	7,952.9
Mesa	3,852,401	20,682,943	2,070	6,937,188	11,852.8	3,351.3
South Phoenix	181,218	16,516,345	837	1,417,166	19,949.3	1,693.1
West Chandler	1,504,898	12,000,108	572	3,789,531	23,610.2	6,625.1
West Phoenix	2,766,951	25,801,155	1,449	7,580,638	19,715.7	5,231.6

**Table 3.10.1b.** Scores from Table 3.10.1a.

Site	Scores			Overall Score
	Traffic Density	Road Density	Average	
Central Phoenix	6	7	6.5	6
Diablo	7	6	6.5	6
West Chandler	5	5	5	5
West Phoenix	3	4	3.5	4
South Phoenix	4	2	3	3
Mesa	2	3	2.5	2
Buckeye	1	1	1	1
Thirty-Third	*	*	*	-

\*Not included due to limited operating time

### 3.10.2 NO<sub>2</sub> Parameter Details

**Table 3.10.2a.** NO<sub>2</sub> monitoring sites Annual Average Daily Traffic (AADT) statistics.

Site	Sum of AADT Counts		Area of Thiessen Polygon (km <sup>2</sup> )	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/Area)
	Highway	Surface				
Buckeye	10,092	1,348,644	5,370	5,041,060	253.0	939
Central Phoenix	3,655,063	14,289,159	482	2,680,554	37,228.7	5,561
Diablo	8,258,538	44,638,572	2,423	11,541,432	21,831.2	4,763
Thirty-Third	1,388,255	5,519,183	769	1,298,661	8,982.4	1,689
West Phoenix	1,680,368	23,603,294	1,278	7,090,687	19,783.8	5,548

**Table 3.10.2b.** Scores from Table 3.10.2a.

Site	Scores			Overall Score
	Traffic Density	Road Density	Average	
Central Phoenix	5	5	5	4
West Phoenix	3	4	3.5	3
Diablo	4	3	3.5	3
Thirty-Third	2	2	2	2
Buckeye	1	1	1	1

### 3.10.3 O<sub>3</sub> Parameter Details

**Table 3.10.3a.** O<sub>3</sub> monitoring sites Annual Average Daily Traffic (AADT) statistics.

Site	Sum of AADT Counts		Area of Thiessen Polygon (km <sup>2</sup> )	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/Area)
	Highway	Surface				
Blue Point	0	49,498	148	145,281	334.4	981.6
Buckeye	94,370	741,942	3,646	3,178,991	229.4	871.9
Cave Creek	207,347	1,770,966	899	1,830,096	2,200.6	2,035.7
Central Phoenix	3,160,534	8,274,650	87	917,490	131,438.9	10,545.9
Dysart	239,335	7,471,804	2,159	5,301,740	3,571.6	2,455.6
Falcon Field	464,524	7,681,869	260	2,259,982	31,332.3	8,692.2
Fountain Hills	0	93,999	139	380,761	676.3	2,739.3
Glendale	954,064	12,468,076	345	3,210,966	38,904.8	9,307.1
Humboldt Mtn.	0	1,034	588	148,817	1.8	253.1
Mesa	2,131,106	7,035,730	106	1,037,636	86,479.6	9,789.0
North Phoenix	2,214,602	12,321,595	263	2,445,637	55,270.7	9,299.0
Pinnacle Peak	479,853	3,286,112	467	1,628,591	8,064.2	3,487.3
South Phoenix	205,988	5,122,592	171	1,095,770	31,161.3	6,408.0
South Scottsdale	0	4,989,557	129	1,084,720	38,678.7	8,408.7
Tempe	3,186,214	8,874,088	114	1,009,904	105,792.1	8,858.8
West Chandler	1,802,623	11,089,557	394	2,743,028	32,721.3	6,962.0
West Phoenix	1,917,062	11,114,463	217	1,767,891	60,053.1	8,147.0

**Table 3.10.3b.** Scores from Table 3.10.3a.

Site	Scores			Overall Score
	Traffic Density	Road Density	Average	
Central Phoenix	17	17	17	16
Mesa	15	16	15.5	15
Tempe	16	13	14.5	14
Glendale	12	15	13.5	13
North Phoenix	13	14	13.5	13
West Phoenix	14	10	12	12
South Scottsdale	11	11	11	11
Falcon Field	9	12	10.5	10
West Chandler	10	9	9.5	9
South Phoenix	8	8	8	8
Pinnacle Peak	7	7	7	7
Dysart	6	5	5.5	6
Fountain Hills	4	6	5	5
Cave Creek	5	4	4.5	4
Blue Point	3	3	3	3
Buckeye	2	2	2	2
Humboldt Mtn.	1	1	1	1

### 3.10.4 PM<sub>10</sub> Parameter Details

**Table 3.10.4a.** PM<sub>10</sub> monitoring sites Annual Average Daily Traffic (AADT) statistics.

Site	Sum of AADT Counts		Area of Thiessen Polygon (km <sup>2</sup> )	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/Area)
	Highway	Surface				
Buckeye	94,370	741,942	3,630	3,177,084	230	875
Central Phoenix	3,160,534	8,176,955	86	900,714	131,831	10,473
Durango Complex	418,413	1,623,598	29	239,128	70,414	8,246
Dysart	198,681	5,829,188	1,541	4,051,827	3,912	2,629
Glendale	623,570	11,577,58	290	2,786,624	42,073	9,609
Higley	971,155	9,759,660	364	2,968,264	29,480	8,155
Mesa	2,131,106	6,763,706	101	975,293	88,067	9,656
North Phoenix	2,384,458	15,024,52	728	3,766,997	23,913	5,174
South Phoenix	195,112	3,651,909	129	796,664	29,822	6,176
South Scottsdale	0	5,292,759	134	1,121,345	39,498	8,368
Tempe	3,186,214	8,874,088	114	1,009,904	105,792	8,859
West 43rd Ave	0	3,887,978	215	1,093,297	18,084	5,085
West Chandler	1,526,540	8,270,273	298	1,943,591	32,875	6,522
West Phoenix	1,509,525	7,772,256	104	1,079,098	89,248	10,376
Zuni Hills	578,495	2,969,494	1,169	2,514,567	3,035	2,151

**Table 3.10.4b.** Scores from Table 3.10.4a.

Site	Scores			Overall Score
	Traffic Density	Road Density	Average	
Central Phoenix	15	15	15.0	14
West Phoenix	13	14	13.5	13
Mesa	12	13	12.5	12
Tempe	14	11	12.5	12
Glendale	10	12	11.0	11
Durango Complex	11	9	10.0	10
South Scottsdale	9	10	9.5	9
West Chandler	8	7	7.5	8
Higley	6	8	7.0	7
South Phoenix	7	6	6.5	6
North Phoenix	5	5	5.0	5
West 43rd Ave	4	4	4.0	4
Dysart	3	3	3.0	3
Zuni Hills	2	2	2.0	2
Buckeye	1	1	1.0	1

### 3.10.5 PM<sub>2.5</sub> Parameter Details

**Table 3.10.5a.** PM<sub>2.5</sub> monitoring sites Annual Average Daily Traffic (AADT) statistics.

Site	Sum of AADT Counts		Area of Thiessen Polygon (km <sup>2</sup> )	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/Area)
	Highway	Surface				
Diablo	3,213,927	8,772,984	279	1,417,201	42,964	5,080
Durango Complex	429,651	4,112,507	1,480	1,271,812	3,069	859
Glendale	1,483,878	20,929,79	4,839	11,558,653	4,632	2,389
Mesa	3,387,140	22,362,20	532	5,029,723	48,401	9,454
North Phoenix	2,396,060	17,076,13	1,125	4,608,230	17,309	4,096
South Phoenix	1,809,558	5,986,692	284	1,059,308	27,452	3,730
Tempe	1,148,246	6,763,900	94	849,506	84,172	9,037
West Phoenix	1,509,525	9,504,514	391	1,805,553	28,169	4,618

**Table 3.10.5b.** Scores from Table 3.10.5a.

Site	Scores			Overall Score
	Traffic Density	Road Density	Average	
Mesa	7	8	7.5	6
Tempe	8	7	7.5	6
Diablo	6	6	6.0	5
West Phoenix	5	5	5.0	4
North Phoenix	3	4	3.5	3
South Phoenix	4	3	3.5	3
Glendale	2	2	2.0	2
Durango Complex	1	1	1.0	1
Thirty-Third	*	*	*	-

\*Not included in analysis due to limited operating time

### 3.10.6 SO<sub>2</sub> Parameter Details

**Table 3.10.6a.** SO<sub>2</sub> monitoring sites Annual Average Daily Traffic (AADT) statistics.

Site	Sum of AADT Counts		Area of Thiessen Polygon (km <sup>2</sup> )	Length of Roads (m)	Traffic Count Density (Sum/Area)	Road Density (Length/Area)
	Highway	Surface				
Central Phoenix	11,741,679	57,046,42	2,706	13,761,269	25,421	5,085
Durango Complex	1,996,506	16,311,43	5,111	7,219,140	3,582	1,412

**Table 3.10.6b.** Scores from Table 3.10.6a.

Site	Scores			Overall Score
	Traffic Density	Road Density	Average	
Central Phoenix	2	2	2.0	2
Durango Complex	1	1	1.0	1

### 3.11 Analysis #11: Environmental Justice-Minority Population Served

The EPA has the mandate of providing an environment where all people enjoy the same degree of protection from environmental and health hazards and equal access to the decision-making process to maintain a healthy environment in which to live, learn, and work<sup>3</sup>. This environmental justice mandate extends to all areas the EPA works with, including air monitoring networks. Thus, this Assessment includes this method as a basic test of how the MCAQD monitoring networks relates to environmental equity issues, in this case minority populations within Maricopa County.

This analysis follows a methodology identical to the population served analysis described earlier; though instead of using total population as a data source, the total population minus the non-Hispanic white population was used to determine the total minority population in each census block group.

The actual methodology was to create Thiessen polygons around each monitoring site to determine the area of representation for each monitor. The total minority population in each census block group from the 2017 ACS Census was calculated and then the census block group polygons were selected by their centroid point and the population within each monitor's Thiessen polygon was determined by summing those centroids that were spatially located within the polygon.

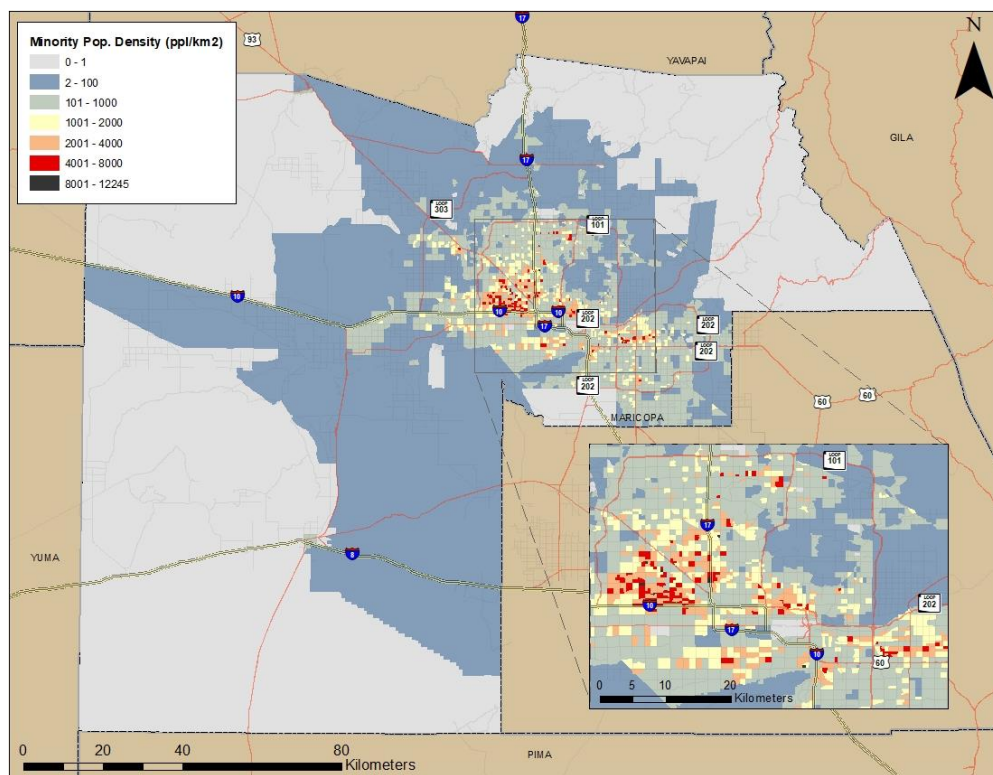
The 2017 Census block groups that were used in this analysis cover the entire Maricopa County area, but only those within the greater metropolitan area were used in the analysis; see Section 3.5, Area Served Analysis, for more details on the analyzed areas. The metropolitan areas included within this analysis only contains 48.5% of the total area of Maricopa County, but contains 99.8% of the population within the County.

Results from each parameter are displayed by using the total population and total minority population to determine the percent minority population within each Thiessen polygon. Sites are then ranked by percent minority population with the highest percentages having the most importance in this analysis.

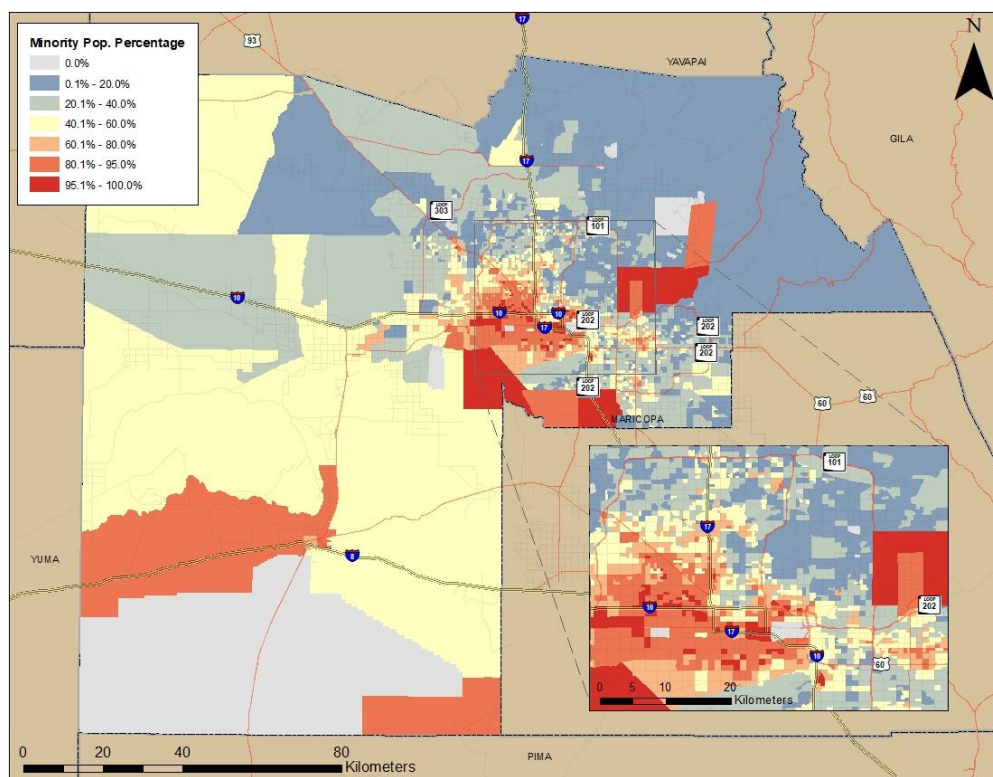
Figure 3.11.1 shows a density map of minority population within Maricopa County, based on the density of population within each census block group of the 2017 ACS Census. Figure 3.11.2, by contrast, shows the percentage of minority population within each census block group. This map highlights areas, such as the tribal reservations, that have a high percentage of minority population, but might not appear on the density map because of the relatively few people per square km living in that census block group.

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<sup>3</sup> U.S. Environmental Protection Agency. (2015). Environmental Justice. <http://www.epa.gov/environmentaljustice/>



**Figure 3.11.1.** Map of minority population density per census block group from the 2017 ACS Census.



**Figure 3.11.2.** Percentage of minority population per census block group from the 2017 ACS Census.

### 3.11.1 CO Parameter Details

**Table 3.11.1.** CO monitoring sites ranked by percentage minority population served.

Site	Total Population Served	Minority Population	% Minority Population	Score
South Phoenix	179,545	136,389	76.0%	7
West Phoenix	1,125,303	640,013	56.9%	6
Central Phoenix	206,714	105,289	50.9%	5
Diablo	242,636	111,776	46.1%	4
Buckeye	194,972	79,920	41.0%	3
West Chandler	453,714	156,075	34.4%	2
Mesa	892,288	282,140	31.6%	1
Dysart	*	*	*	-
Glendale	*	*	*	-
Greenwood	*	*	*	-
North Phoenix	*	*	*	-
South Scottsdale	*	*	*	-
Thirty-Third	**	**	**	-

\*These CO sites were closed before December 2019 and were not included in the analysis.

\*\*Not included due to limited operating time.

Note: There were 9,895 people in Maricopa County, out of a total population of 4,155,501, who lived outside of the CO analysis area (see section 3.5.1 for details on the analysis area); 39.5% of the population outside of the CO analysis area are minority populations.

### 3.11.2 NO<sub>2</sub> Parameter Details

**Table 3.11.2.** NO<sub>2</sub> monitoring sites, ranked by percentage minority population served.

Site	Total Population Served	Minority Population	% Minority Population	Score
Thirty-third	161,115	131,080	81.4%	5
West Phoenix	1,055,787	579,417	54.9%	4
Central Phoenix	331,852	171,808	51.8%	3
Buckeye	194,972	79,920	41.0%	2
Diablo	1,549,336	551,453	35.6%	1
Greenwood	*	*	*	-

\*The Greenwood site was closed in June 2016 and was not included in the analysis.

Note: There were 9,895 people in Maricopa County, out of a total population of 4,155,501, who lived outside of the NO<sub>2</sub> analysis area (see section 3.5.2 for details on analysis area); 39.5% of the population outside of the NO<sub>2</sub> analysis area are minority populations.

### 3.11.3 O<sub>3</sub> Parameter Details

**Table 3.11.3.** O<sub>3</sub> monitoring sites, ranked by percentage minority population served.

Site	Total Population Served	Minority Population	% Minority Population	Score
West Phoenix	369,107	319,054	86%	17

South Phoenix	177,714	132,053	74%	16
Central Phoenix	150,905	95,244	63%	15
Mesa	216,224	106,542	49%	14
Tempe	180,854	88,838	49%	13
Buckeye	99,422	46,635	47%	12
Glendale	554,386	251,994	45%	11
West Chandler	357,442	132,606	37%	10
North Phoenix	380,825	134,558	35%	9
Dysart	452,871	146,935	32%	8
South Scottsdale	151,846	40,874	27%	7
Falcon Field	328,172	86,334	26%	6
Blue Point	1,709	335	20%	5
Cave Creek	126,974	22,004	17%	4
Pinnacle Peak	116,486	18,028	15%	3
Fountain Hills	32,353	3,325	10%	2
Humboldt Mountain	0	0	0%	1
Rio Verde	*	*	*	-

\*The Rio Verde site was closed in October 2017 and was not included in the analysis.

Note: There were 9,895 people in Maricopa County, out of a total population of 4,155,501, who lived outside of the O<sub>3</sub> analysis area (see section 3.5.3 for details on analysis area); 39.5% of the population outside of the O<sub>3</sub> analysis area are minority populations.

#### 3.11.4 PM<sub>10</sub> Parameter Details

**Table 3.11.4.** PM<sub>10</sub> monitoring sites, ranked by percentage minority population served.

Site	Total Population Served	Minority Population	% Minority Population	Score
West Phoenix	266,439	233,329	87.6%	15
Durango Complex	33,618	28,919	86.0%	14
West 43rd Ave	148,571	120,170	80.9%	13
South Phoenix	129,548	92,953	71.8%	12
Central Phoenix	149,157	94,097	63.1%	11
Mesa	202,562	101,567	50.1%	10
Tempe	180,854	88,838	49.1%	9
Glendale	491,770	238,803	48.6%	8
Buckeye	93,480	43,301	46.3%	7
West Chandler	267,731	103,557	38.7%	6
Dysart	365,184	128,576	35.2%	5
North Phoenix	490,620	154,163	31.4%	4
Higley	381,490	107,873	28.3%	3
South Scottsdale	156,993	41,685	26.6%	2
Zuni Hills	202,466	37,225	18.4%	1
Greenwood	-	-	-	*

\*The Greenwood site was closed in June 2016 and was not included in the analysis.

Note: There were 9,895 people in Maricopa County, out of a total population of 4,155,501, who lived outside of the PM<sub>10</sub> analysis area (see section 3.5.4 for details on analysis area); 39.5% of the population outside of the PM<sub>10</sub> analysis area are minority populations.

### 3.11.5 PM<sub>2.5</sub> Parameter Details

**Table 3.11.5.** PM<sub>2.5</sub> monitoring sites, ranked by percentage minority population served.

Site	Total Population Served	Minority Population	% Minority Population	Score
West Phoenix	349,558	294,314	84%	8
Durango Complex	122,749	99,482	81%	7
South Phoenix	142,049	105,648	74%	6
Diablo	214,769	115,191	54%	5
Tempe	165,317	65,395	40%	4
Glendale	1,130,032	441,682	39%	3
Mesa	788,857	299,985	38%	2
North Phoenix	539,605	162,278	30%	1
Thirty-Third	*	*	*	-

\*Not included in analysis due to limited operating time

Note: There were 9,895 people in Maricopa County, out of a total population of 4,155,501, who lived outside of the PM<sub>2.5</sub> analysis area (see section 3.5.5 for details on analysis area); 39.5% of the population outside of the PM<sub>2.5</sub> analysis area are minority populations.

### 3.11.6 SO<sub>2</sub> Parameter Details

**Table 3.11.6.** SO<sub>2</sub> monitoring sites, ranked by percentage minority population served.

Site	Total Population Served	Minority Population	% Minority Population	Score
Durango Complex	706,834	501,844	71%	2
Central Phoenix	1,816,630	679,596	37%	1

Note: There were 9,895 people in Maricopa County, out of a total population of 4,155,501, who lived outside of the SO<sub>2</sub> analysis area (see section 3.5.6 for details on analysis area); 39.5% of the population outside of the SO<sub>2</sub> analysis area are minority populations.

## 3.12 Results

The scores from each analysis method have been displayed for each monitoring site in each parameter network. In order to evaluate each parameter network, the scores from each analysis were averaged together and the sites were ranked by their average score. In this manner, the order of importance of the sites for each parameter was determined.

The objective of having multiple analysis methods is to produce a comprehensive perspective of evaluation with many variables, such as: cost-effectiveness, suitability for modeling, proximity to population and sources, correlations and redundancies, and concentrations monitored. However, it is not assumed that all methods are of equal importance. For instance, pollutant concentrations are often looked upon as very important. To reflect this relative importance, weights were chosen for each method and applied to the score. These final weighted scores are those that are averaged to determine the final rank. For this assessment, weights were derived by surveying a panel of air quality experts, policymakers, and academics to get their opinion on the relative importance of these analyses<sup>4</sup>. Survey answers were averaged together and used for the weighting scheme (Table 3.12.1).

### 3.12.1 Weights

The following weighting guidelines were used for each analysis:

**Table 3.12.1.** Weights applied to each analysis result.

Analysis #	Analysis	Weight (Ozone Only)	Weight (All Others)
1	Number of other parameters	5%	5%
2	Trends Impact	10%	10%
3	Measured Concentrations	13%	14%
4	Deviation from the NAAQS	9%	9%
5	Area Served	8%	8%
6	Population Served	8%	10%
7	Monitor-to-Monitor Correlation	7%	6%
8	Removal Bias	8%	8%
9a	Emissions Inventory	8%	12%
9b (O <sub>3</sub> only)	Predicted Ozone	9%	N/A
10	Traffic Counts	8%	9%
11	Environmental Justice	7%	9%

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<sup>4</sup> Pope, R. L. & J. Wu. (2014) A Multi-Objective Assessment of an Air Quality Monitoring Network Using Environmental, Economic, and Social Indicators and GIS-Based Models. Journal of the Air & Waste Management Association 64(6):721-37.

### 3.12.2 Results for CO

There were seven MCAQD CO sites evaluated by the eleven analyses used in this section of the Assessment. The scores from each of these analyses were weighted and averaged and ranks were assigned by the final weighted average.

Table 3.12.2 shows the final results of the CO evaluation where the scores have been converted to rank and Table 3.12.3 shows the breakdown of the data per analysis by raw scores with the final weighted average.

**Table 3.12.2.** Final average rankings for CO sites.

Site	Rank	Site	Rank
West Phoenix	1	Diablo	5
Central Phoenix	2	West Chandler	6
South Phoenix	3	Buckeye	7
Mesa	4		

**Table 3.12.3.** Raw scores for CO analyses.

Site	Number of other Parameters monitored	Trends Impact	Measured Concentrations	Deviation from the NAAQS	Area Served	Population Served	Monitor-to-Monitor Correlation	Removal Bias	Emissions Inventory	Traffic Counts	Environmental Justice	Weighted Average	Rank
Buckeye	2	2	1	1	7	2	7	-	1	1	3	2.4	7
Central Phoenix	3	7	5	5	2	3	2	1	5	6	5	4.3	2
Diablo	1	1	3	3	1	4	4	4	6	6	4	3.5	5
Mesa	2	5	4	4	6	6	6	6	2	2	1	4.0	4
South Phoenix	2	6	6	6	4	1	3	3	3	3	7	4.2	3
West Chandler	1	3	2	2	3	5	5	2	7	5	2	3.5	6
West Phoenix	4	4	7	7	5	7	1	5	4	4	6	5.2	1
<b>WEIGHT</b>	5%	10%	14%	9%	8%	10%	6%	8%	12%	9%	9%		

### 3.12.3 Results for NO<sub>2</sub>

There were five MCAQD NO<sub>2</sub> sites evaluated by the analyses used in this section of the Assessment. Table 3.12.4 shows the final results of the NO<sub>2</sub> evaluation. Table 3.12.5 shows the breakdown of the data per analysis by raw scores and weighted average.

Note that the Diablo site was permanently closed in January 2020, but it is included in these analyses because a nearby replacement site, with presumably similar characteristics, is planned to be open in late 2020 or early 2021.

**Table 3.12.4.** Final rankings for NO<sub>2</sub> sites

Site	Rank
Thirty-Third	1
Diablo	2
West Phoenix	3
Central Phoenix	4
Buckeye	5

**Table 3.12.5.** Raw scores for NO<sub>2</sub> analyses

Site	Number of other Parameters monitored	Trends Impact	Measured Concentrations	Deviation from the NAAQS	Area Served	Population Served	Monitor-to-Monitor Correlation	Removal Bias	Emissions Inventory	Traffic Counts	Environmental Justice	Weighted Average	Rank
Buckeye	2	3	1	1	5	2	3	-	1	1	2	1.96	5
Central Phoenix	3	5	4	3	1	3	2	1	2	4	3	2.93	4
Diablo	1	2	3	4	4	5	5	-	3	3	1	3.12	2
Thirty-Third	1	1	5	5	2	1	4	3	5	2	5	3.27	1
West Phoenix	4	4	2	2	3	4	1	2	4	3	4	3.03	3
<b>WEIGHT</b>	5%	10%	14%	9%	8%	10%	6%	8%	12%	9%	9%		

### 3.12.4 Results for O<sub>3</sub>

There were seventeen MCAQD O<sub>3</sub> sites evaluated by the analyses used in this section of the Assessment. Table 3.12.6 shows the final results of the O<sub>3</sub> evaluation. Table 3.12.7 shows the breakdown of the data per analysis by raw scores and weighted average.

**Table 3.12.6.** Final rankings for O<sub>3</sub> sites

Site	Rank	Site	Rank	Site	Rank
North Phoenix	1	Humboldt	7	Cave Creek	13
Pinnacle Peak	2	Central Phoenix	8.5	South Scottsdale	14
West Phoenix	3	West Chandler	8.5	Buckeye	15
Mesa	4	Dysart	10	Tempe	16
Falcon Field	5	South Phoenix	11	Fountain Hills	17
Glendale	6	Blue Point	12		

**Table 3.12.7.** Raw scores for O<sub>3</sub> analyses

Site	Number of other Parameters monitored	Trends Impact	Measured Concentrations	Deviation from the NAAQS	Area Served	Population Served	Monitor-to-Monitor Correlation	Removal Bias	Emissions Inventory	Predicted Ozone	Traffic Counts	Environ-mental Justice	Weighted Average	Rank
Blue Point	1	7	12	13	6	2	13	12	1	13	3	5	7.8	12
Buckeye	4	2	2	2	17	4	12	16	5	6	2	12	6.6	15
Cave Creek	1	4	7	7	15	6	15	5	4	15	4	4	7.4	13
Central Phoenix	5	13	9	9	1	7	2	4	16	2	16	15	8.4	8.5
Dysart	2	3	5	5	16	16	11	13	6	10	6	8	8.3	10
Falcon Field	1	8	13	15	9	12	4	7	9	12	10	6	9.4	5
Fountain Hills	1	6	6	6	5	3	10	3	3	14	5	2	5.6	17
Glendale	3	12	3	3	11	17	8	11	11	7	13	11	9.0	6
Humboldt	1	7	11	12	14	1	16	17	2	17	1	1	8.8	7
Mesa	4	1	16	11	2	11	5	14	13	9	15	14	9.9	4
North Phoenix	4	11	14	14	10	15	6	6	10	11	13	9	10.7	1
Pinnacle Peak	1	9	15	12	13	5	14	15	7	16	7	3	10.4	2
South Phoenix	4	11	8	8	7	9	3	2	14	3	8	16	7.9	11
South Scottsdale	2	12	4	4	4	8	7	8	8	5	11	7	6.7	14
Tempe	4	5	1	1	3	10	5	10	15	1	14	13	6.4	16
West Chandler	3	7	8	8	12	13	9	1	12	8	9	10	8.4	8.5
West Phoenix	6	10	10	10	8	14	1	9	17	4	12	17	9.9	3
<b>WEIGHT</b>	5%	10%	13%	9%	8%	8%	7%	8%	8%	9%	8%	7%		

### 3.12.5 Results for PM<sub>10</sub>

There were fifteen MCAQD PM<sub>10</sub> sites evaluated by the analyses used in this section of the Assessment. Table 3.12.8 shows the final results of the PM<sub>10</sub> evaluation. Table 3.12.9 shows the breakdown of the data per analysis by raw scores and weighted average.

**Table 3.12.8.** Final average rankings for PM<sub>10</sub> sites

Site	Rank	Site	Rank
West 43rd Avenue	1	West Phoenix	8.5
West Chandler	2	North Phoenix	10
Higley	3	South Phoenix	11
Durango Complex	4	Tempe	12
Central Phoenix	5	Dysart	13
Buckeye	6	South Scottsdale	14
Glendale	7	Zuni Hills	15
Mesa	8.5		

**Table 3.12.9.** Raw scores for PM<sub>10</sub> analyses

Site	Number of other Parameters monitored	Trends Impact	Measured Concentrations	Deviation from the NAAQS	Area Served	Population Served	Monitor-to-Monitor Correlation	Removal Bias	Emissions Inventory	Traffic Counts	Environmental Justice	Weighted Average	Rank
Buckeye	4	3	12	12	15	2	11	14	5	1	7	7.76	6
Central	5	12	8	8	2	5	1	7	8	14	11	7.78	5
Durango	3	7	11	11	1	1	4	5	15	10	14	8.16	4
Dysart	2	4	6	6	14	12	6	2	4	3	5	5.92	13
Glendale	3	11	2	2	9	15	2	12	7	11	8	7.56	7
Higley	2	6	13	13	11	13	2	9	6	7	3	8.33	3
Mesa	4	9	3	3	3	9	8	10	11	12	10	7.51	8.5
North	4	9	5	5	12	14	7	13	3	5	4	7.24	10
South	4	12	4	4	6	3	5	8	10	6	12	6.86	11
South	2	11	7	7	7	6	3	3	2	9	2	5.62	14
Tempe	4	1	1	1	5	7	8	11	12	12	9	6.32	12
West 43rd	2	5	14	14	8	4	9	15	13	4	13	9.69	1
West	3	8	10	10	10	11	2	4	14	8	6	8.53	2
West	6	10	3	3	4	10	2	6	9	13	15	7.51	8.5
Zuni Hills	1	2	9	9	13	8	10	1	1	2	1	5.23	15
WEIGHT	5%	10%	14%	9%	8%	10%	6%	8%	12%	9%	9%		

### 3.12.6 Results for PM<sub>2.5</sub>

There were eight MCAQD PM<sub>2.5</sub> sites evaluated by the analyses used in this section of the Assessment. Table 3.12.10 shows the final results of the PM<sub>2.5</sub> evaluation. Table 3.12.11 shows the breakdown of the data per analysis by raw scores and weighted averages. Note that the Diablo site was permanently closed in January 2020, but it is included in these analyses because a nearby replacement site, with presumably similar characteristics, is planned to be open in late 2020 or early 2021.

**Table 3.12.10.** Final rankings for PM<sub>2.5</sub> sites

Site	Rank	Site	Rank
West Phoenix	1	Mesa	5
Durango Complex	2	Diablo	6
Glendale	3	North Phoenix	7
South Phoenix	4	Tempe	8

**Table 3.12.11.** Raw scores for PM<sub>2.5</sub> analyses

Site	Number of other Parameters monitored	Trends Impact	Measured Concentrations	Deviation from the NAAQS	Area Served	Population Served	Monitor-to-Monitor Correlation	Removal Bias	Emissions Inventory	Traffic Counts	Environmental Justice	Weighted Average	Rank
Diablo	1	1	5	5	2	4	5	2	-	5	5	3.22	6
Durango Complex	1	4	7	7	7	1	3	7	-	1	7	4.18	2
Glendale	1	3	4	4	8	8	2	6	-	2	3	3.76	3
Mesa	2	5	2	2	5	7	6	1	-	6	2	3.32	5
North Phoenix	2	3	3	3	6	6	4	5	-	3	1	3.17	7
South Phoenix	2	5	6	6	3	2	1	3	-	3	6	3.53	4
Tempe	2	2	1	1	1	3	5	4	-	6	4	2.43	8
West Phoenix	3	6	8	8	4	5	1	8	-	4	8	5.19	1
<b>WEIGHT</b>	5%	10%	14%	9%	8%	10%	6%	8%	12%	9%	9%		

### 3.12.7 Results for SO<sub>2</sub>

There are only two SO<sub>2</sub> sites in the MCAQD network. Table 3.12.12 shows the final results of the SO<sub>2</sub> evaluation. Table 3.12.13 shows the breakdown of the data per analysis by raw scores and weighted averages.

**Table 3.12.12.** Final rankings for SO<sub>2</sub> sites

Site	Rank
Central Phoenix	Tie
Durango Complex	Tie

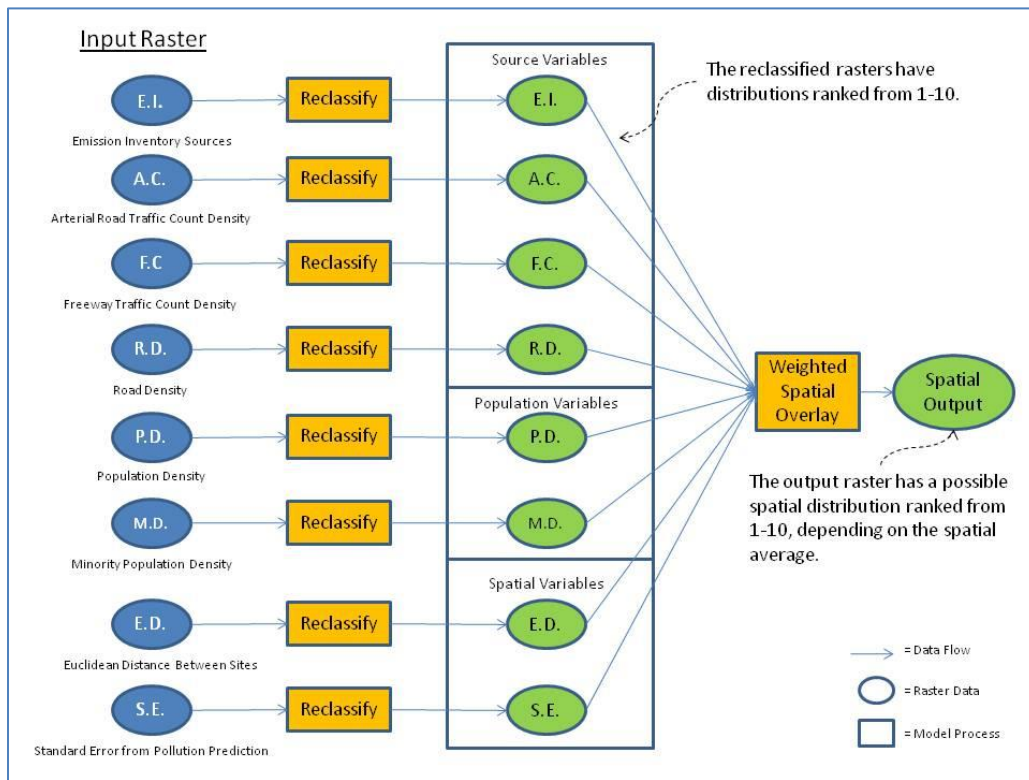
**Table 3.12.13.** Raw scores for SO<sub>2</sub> analyses

Site	Number of other Parameters Monitored	Trends Impact	Measured Concentrations	Deviation from the NAAQS	Area Served	Population Served	Monitor-to-Monitor Correlation	Removal Bias	Emissions Inventory	Traffic Counts	Environmental Justice	Weighted Average	Rank
Central Phoenix	2	2	1	1	1	2	1	-	2	2	1	1.38	-
Durango Complex	1	1	2	2	2	1	2	-	1	1	2	1.38	-
<b>WEIGHT</b>	5%	10%	14%	9%	8%	10%	6%	8%	12%	9%	9%		

## Section 4: Adequacy of the Current Air Monitoring Network

This section attempts to determine if the existing ambient monitoring network adequately represents Maricopa County in the areas of population coverage, source coverage, and spatial coverage. The analysis takes eight different indicators in three different variable areas and reclassifies them into GIS rasters with a common ranking system. The rasters are then combined in a spatially averaged overlay which provides a location score showing areas of potential air monitoring priority. The overlay is weighted toward certain variables, depending on the pollution parameter. Weights are assigned *ad hoc*, based on expert opinion of air pollution scientists<sup>5</sup>.

As depicted in Figure 4.0.1, input spatial data are first converted to raster format within the GIS. Each raster is then reclassified to a congruous scale of 1-10, based on a partition of the data distribution, using Jenks natural breaks<sup>6</sup>, within that variable. The reclassified rasters are then aggregated into a weighted spatial overlay which displays the weighted average in each spatial location.



**Figure 4.0.1.** Model for assessing air monitoring spatial scores.

<sup>5</sup> Pope, R. L. & J. Wu. (2014) A Multi-Objective Assessment of an Air Quality Monitoring Network Using Environmental, Economic, and Social Indicators and GIS-Based Models. *Journal of the Air & Waste Management Association* 64(6):721-37.

<sup>6</sup> A method of statistical data classification that partitions data into classes using an algorithm that calculates groupings of data values based on the data distribution. Jenks' optimization seeks to reduce variance within groups and maximize variance between groups.

This spatial output raster depicts a spatially-explicit scored map. The score represents the air monitoring priority of the location. Possible scores are 1-10, though this score does represent an average of all the input analysis variables, so in this Assessment the results scores vary.

## **4.1 Description of Analysis Indicators**

Indicators are grouped into three separate categories: source, population, and spatially oriented. These categories are organized so as to simplify assigning weights and make the weighting process transparent. Weights are assigned differently to each pollution parameter, because they are based on the characteristics of that parameter.

### **4.1.1 Source-Oriented Indicators**

- Indicator #1: Emissions Inventory Point Sources

This indicator creates a raster map of point source emissions from the MCAQD Emissions Inventory Report. The emission sources are aggregated into each township, range, and section; the sum of emissions in each sector, aka emission sections, is used as the raster value. When reclassifying the raster, the entire distribution of emission sections is divided into 10 parts and assigned a score of 1-10 with 10 being the highest partition.

- Indicator #2: Arterial Road Traffic Count

First of the mobile source indicators, this uses the annual average daily traffic (AADT) count from arterial, collector, and local surface roads in Maricopa County. AADT counts are averaged in each township, range, and section, with the average result being used as the raster value. Higher AADT counts are assigned higher scores.

- Indicator #3: Highway Traffic Count

Second of the mobile source indicators and similar to the Arterial Road Traffic Count, this indicator uses the AADT from interstate and state highways in Maricopa County. Highway AADT counts are also averaged in each township, range, and section. Higher AADT counts are assigned higher scores.

- Indicator #4: Road Density

Third of the mobile source indicators, this assesses the density of roads, including highways, arterials, collectors, and local roads in a given area and returns the result as the raster value. This indicator is designed to give support to the traffic counts in determining emissions from mobile sources. Since traffic counts are based upon discrete sampling locations and it is difficult to ascertain if these locations are evenly sampled, the road density will serve as another proxy in determining mobile source emissions. The indicator works by calculating the density of roads (lines) within the current and adjacent cells. Higher densities are assigned higher scores.

### **4.1.2 Population-Oriented Indicators**

- Indicator #5: Population Density

This indicator uses the 2017 American Community Survey (ACS) Census block groups to account for total population. The population density of each block group (population/block group area) is

calculated and this value is used for the raster. Higher population densities are assigned higher scores since it is desirable to have a monitor representing the greatest number of people.

- Indicator #6: Minority Population Density

This indicator is identical in design to the Population Density variable above, except that instead of total population in each census block group, the minority (non-white and non-Hispanic) population is used. This indicator provides a method of accounting for environmental equity issues. Areas with higher minority population densities are assigned higher scores.

#### 4.1.3 Spatially Oriented Indicators

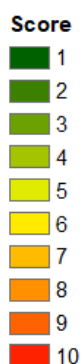
- Indicator #7: Euclidean Distance between Monitors

This indicator calculates and assigns scores based on the straight-line distance away from an existing monitoring site. The implied assumption is that it is more desirable to have a new monitoring site farther away from an existing site. The score increases the farther away in distance that the location is from existing monitoring sites.

- Indicator #8: Standard Error from Predicted Pollution

This indicator accounts for the actual modeled pollution surface. This is accomplished by creating a kriging interpolation map for each pollution parameter using the 5-year average data from each existing monitoring site. However, instead of a standard pollution surface output, a standard error map is generated. This map shows areas of highest uncertainty in the kriging model. After converting the map to a raster, the areas of highest uncertainty are reclassified with the highest score.

The spatial output results for each pollution parameter are displayed as a scored map. Possible scores on the final map range from 1 to 10, with higher scores indicating a location that has higher priority for air monitoring. The maps use a common color scheme, from green to red, for the scores; Figure 4.1.1 displays that color scheme.



**Figure 4.1.1** Common color scheme that will be used to display spatial scores on all final weighted overlay maps.

An explanation and justification for the weights used are also given. Recommendations for modifying the monitoring network are not made in this section; rather those recommendations are made in Section 5 where

results and information from the previous sections are brought together to provide comprehensive reasons to modify the MCAQD network.

## 4.2 CO Parameter Results

### 4.2.1 Weights used

**Table 4.2.1.** CO Weights

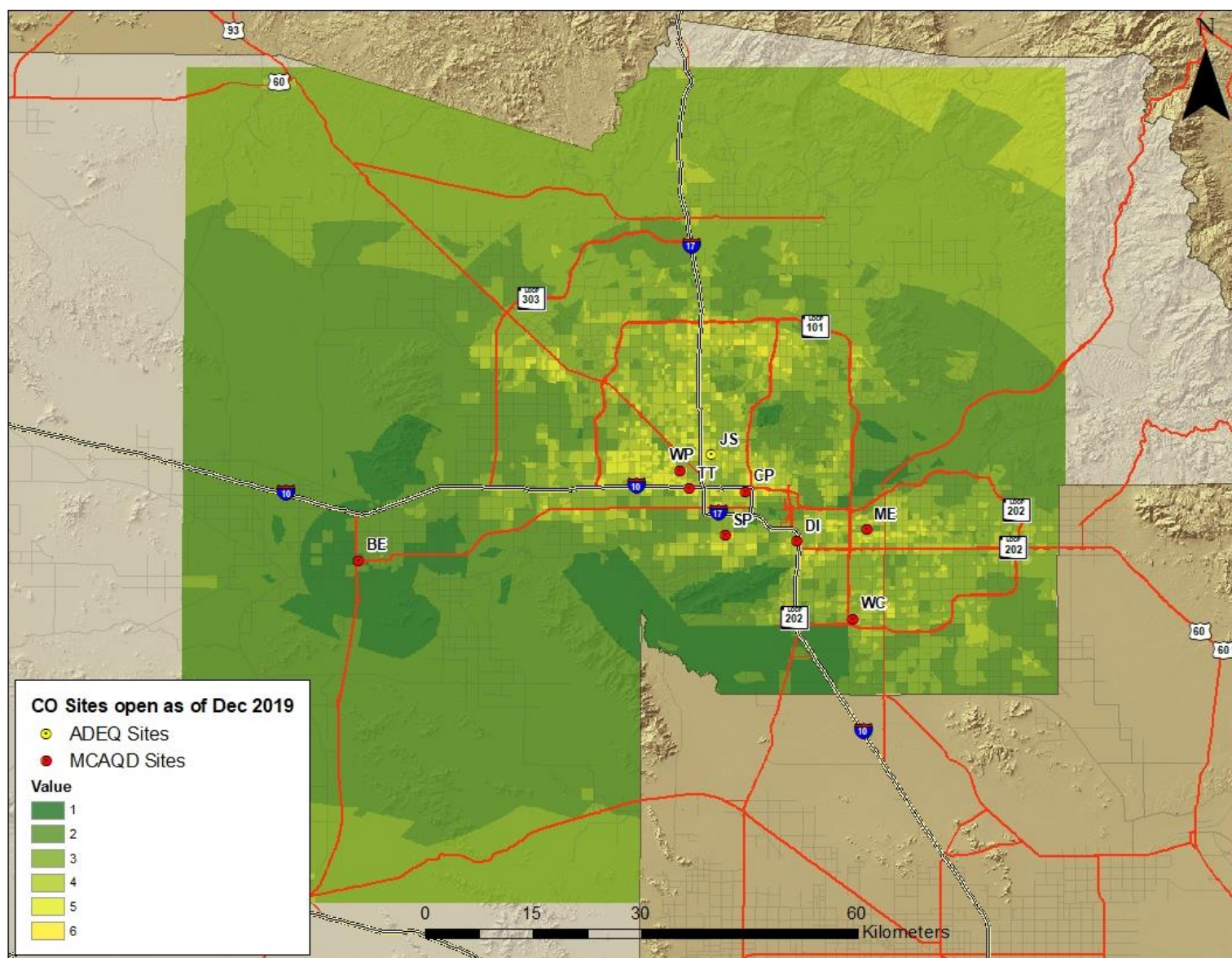
Area	Indicator	Weights	
Source-Oriented Indicators		.35	
	Emissions Inventory Point-Sources	.12	
	Arterial Road Traffic Count	.09	
	Highway Traffic Count	.07	
	Road Density	.07	
Population-Oriented Indicators		.35	
	Population Density	.15	
	Minority Population Density	.20	
Spatially-Oriented Indicators		.30	
	Euclidean Distance Between Monitors	.16	
	Standard Error from Predicted Pollution	.14	
Totals		1.0	1.0

### 4.2.2 Justification

CO emission sources tend to be highest among mobile sources, especially among arterial roads where vehicles spend more time idling; therefore, mobile source indicators are given almost twice the weight of point-sources. The source-oriented variables themselves are given slightly higher weight.

In recent years, CO has become a pollutant that is highly associated with urban environments. It mostly occurs in areas of high population, especially in areas of high minority population. Therefore, more weight was assigned to minority population density, while the population-oriented variable was given slightly lower weight.

Correlation between CO monitoring sites decreases rapidly while moving away from existing sites (see Figure 3.7.2, Correlogram of CO Monitoring Sites); therefore, CO sites can be located relatively close together and still be useful. Spatially-oriented variables were given a slightly lower weight than the other variables to deemphasize the effects of distance in respect to sources and population.



**Figure 4.2.1.** Map showing overlay of CO scores for potential air monitoring priority.

## 4.3 NO<sub>2</sub> Parameter Results

### 4.3.1 Weights Used

**Table 4.3.1.** NO<sub>2</sub> Weights

Area	Indicator	Weights	
Source-Oriented Indicators		.38	
	Emissions Inventory Point-Sources		.15
	Arterial Road Traffic Count		.08
	Highway Traffic Count		.08
	Road Density		.07
Population-Oriented Indicators		.37	
	Population Density		.17
	Minority Population Density		.20
Spatially-Oriented Indicators		.25	
	Euclidean Distance Between Monitors		.12
	Standard Error from Predicted Pollution		.13
Totals		1.0	1.0

### 4.3.2 Justification

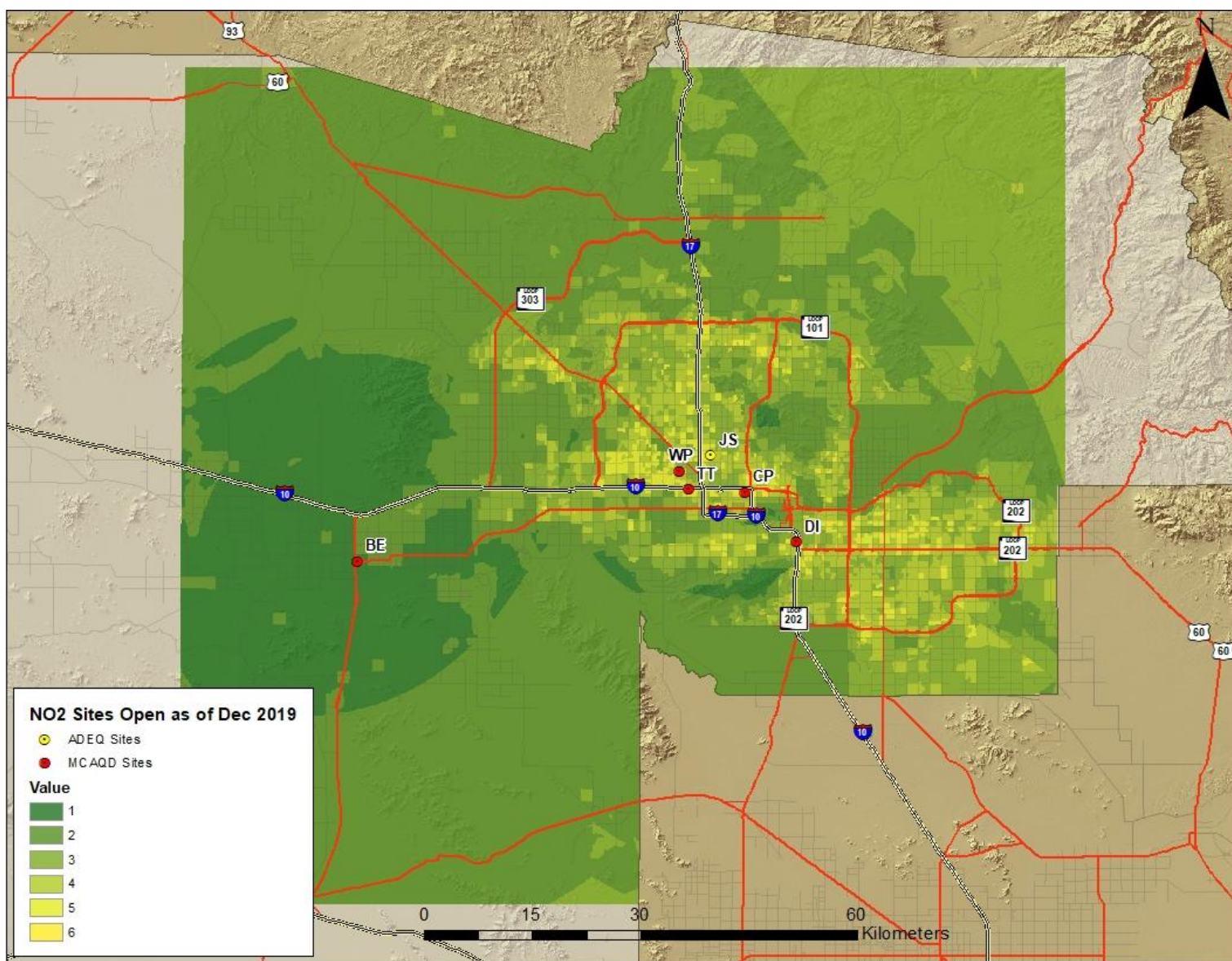
NO<sub>2</sub> sources are a mix of mobile and point-sources, though the EPA lists on-road vehicles as the highest source in Maricopa County<sup>7</sup>, followed by non-road equipment. Therefore, source-oriented indicators are given the highest weight and the traffic indicators have more of that weight than point-sources.

NO<sub>2</sub> tends to be a highly urban pollutant found in areas of high population, especially in areas of high minority population. Therefore, more weight is assigned to minority population density; while the population-oriented variables are given weight just slightly lower than source-oriented.

Correlation between NO<sub>2</sub> sites was relatively high, with 75% correlation at 5 km (see Figure 3.7.4, Correlogram of NO<sub>2</sub> Monitoring Sites). The correlogram also shows that this spatial correlation persists for a longer range, so NO<sub>2</sub> sites should be located farther apart to reduce the chance of redundancy.

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<sup>7</sup> U.S. Environmental Protection Agency (2010) Air Emission Sources, <http://www.epa.gov/air/emissions/>.



**Figure 4.3.1.** Map showing overlay of NO<sub>2</sub> scores for potential air monitoring priority.

## 4.4 O<sub>3</sub> Parameter Results

### 4.4.1 Weights Used

**Table 4.4.1.** O<sub>3</sub> Weights

Area	Indicator	Weights	
Source-Oriented Variables		.40	
	Emissions Inventory Point-Sources		.13
	Arterial Road Traffic Count		.09
	Highway Traffic Count		.08
	Road Density		.10
Population-Oriented Variables		.32	
	Population Density		.18
	Minority Population Density		.14
Spatially-Oriented Variables		.28	
	Euclidean Distance Between Monitors		.13
	Standard Error from Predicted Pollution		.15
Totals		1.0	1.0

### 4.4.2 Justification

O<sub>3</sub> is a secondary pollutant that is indirectly related to the emissions from sources. However, the panel of experts that decided on weights for the O<sub>3</sub> analysis felt that the locations of precursor sources, especially mobile sources, were important to the siting of O<sub>3</sub> monitoring sites. This category of source-oriented variables includes stationary facilities, e.g. solvent-using facilities, combustion sources, and mobile traffic sources of VOCs.

O<sub>3</sub> is a pollutant with considerable immediate health concerns; therefore, it is important to have O<sub>3</sub> monitors near high populations. The highest long term O<sub>3</sub> concentrations tend to occur in rural areas away from high population densities, including minority populations. Because of these dynamics, the population-oriented variables are only given a medium weight with the population density indicator have more weight than the minority population density Indicator.

O<sub>3</sub> monitoring sites tend to be highly correlated up to 20 km apart (see Figure 3.7.6, Correlogram of O<sub>3</sub> Monitoring Sites). Correlations tend to stay high, even at greater distances, which show that having a network of O<sub>3</sub> monitoring sites close together is not necessary. The Euclidean Distance indicator was given relatively low weight but the Standard Error indicator, on the other hand, is the only way to factor secondary-forming pollution into this model so it is given slightly higher weight.

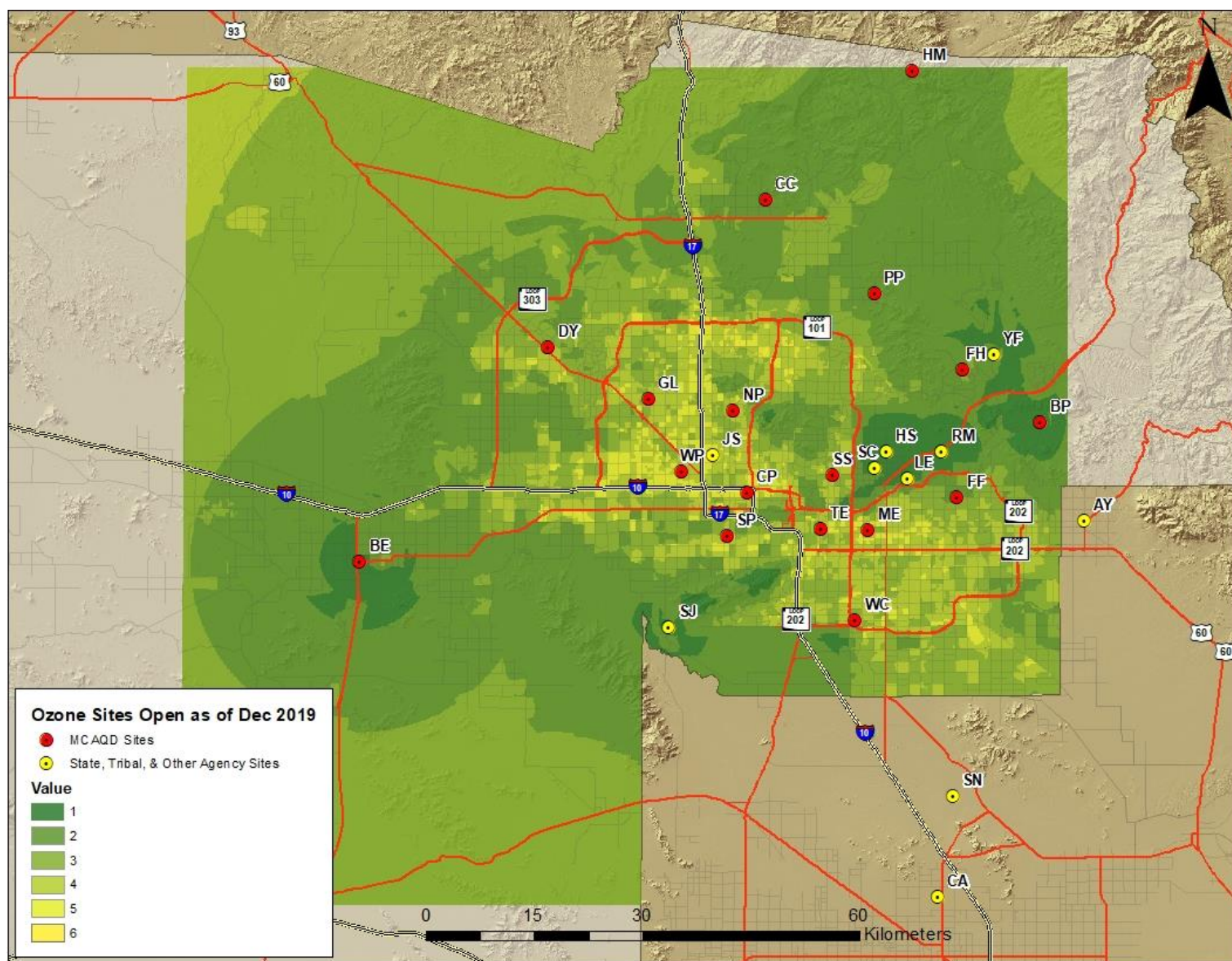


Figure 4.4.1. Map showing overlay of O<sub>3</sub> scores for potential air monitoring priority.

## 4.5 PM<sub>10</sub> Parameter Results

### 4.5.1 Weights Used

Table 4.5.1. PM<sub>10</sub> Weights

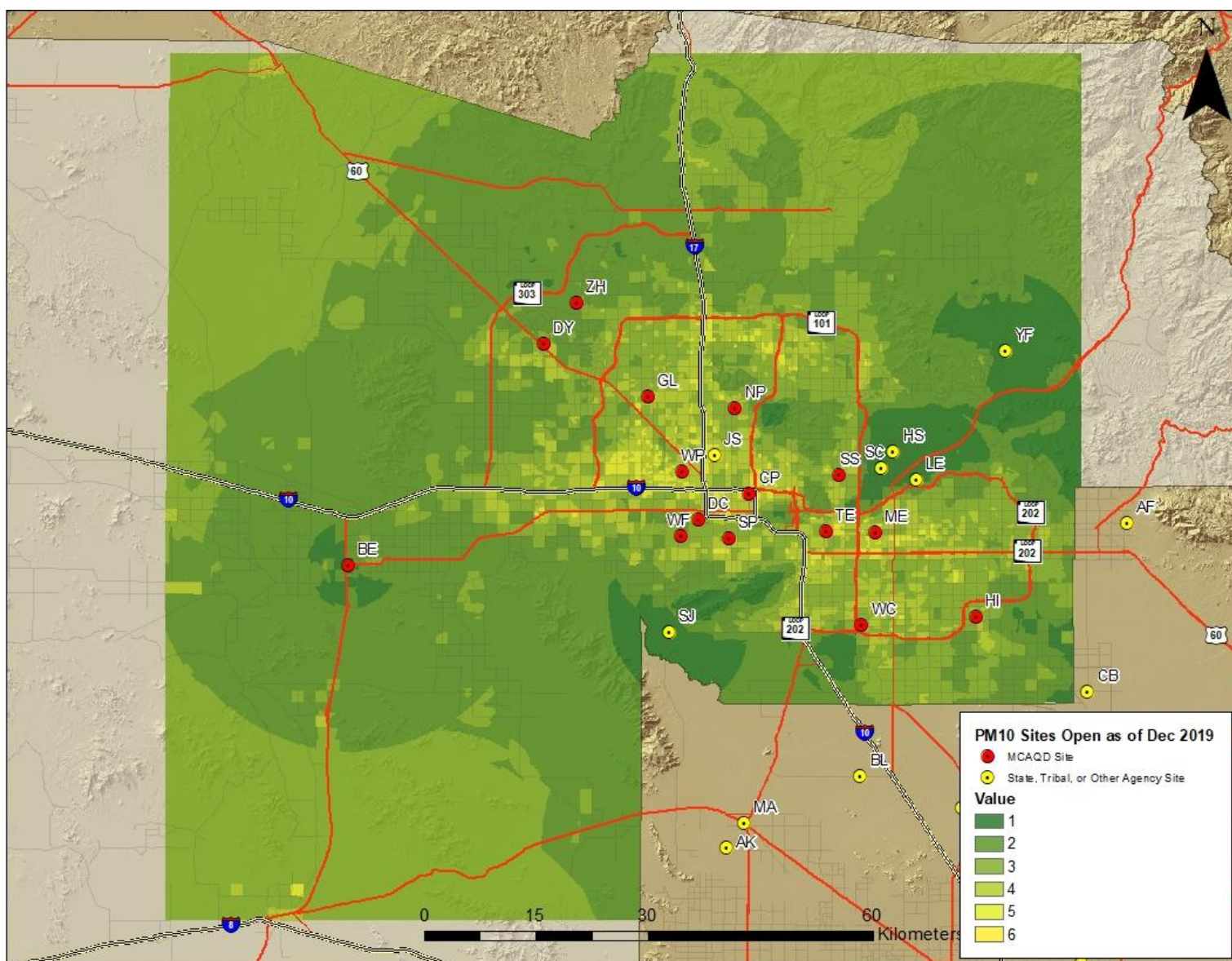
Area	Indicator	Weights	
Source-Oriented Variables		.47	
	Emissions Inventory Point-Sources		.20
	Arterial Road Traffic Count		.09
	Highway Traffic Count		.08
	Road Density		.10
Population-Oriented Variables		.29	
	Population Density		.16
	Minority Population Density		.13
Spatially-Oriented Variables		.24	
	Euclidean Distance Between Monitors		.12
	Standard Error from Predicted Pollution		.12
Totals		1.0	1.0

### 4.5.2 Justification

Based on evaluation of the re-classed emissions inventory map created for this section and the highest concentration analysis from Section 3, it has been shown that known PM<sub>10</sub> concentrations have a strong relationship with point-sources; though several of the top sites with the highest concentrations (Buckeye and Higley) seemed to be impacted more from agricultural, natural, and/or area sources than PM<sub>10</sub> sources listed in the inventory. Because of this, the Source-Oriented variable is given the highest weight in this model, and the Emissions Inventory Point-sources indicator is given the highest weight inside the variable.

Known PM<sub>10</sub> concentrations in the long term tend to be highest in rural areas and industrial areas, though there is a significant impact on urban areas within the metropolitan area. Therefore, the Population-Oriented variables were given a fair amount of weight, though less than the Source-Oriented variables.

PM<sub>10</sub> monitoring sites tend to quickly lose correlation with distance, almost in a linear fashion (see Figure 3.7.8, Correlogram of PM<sub>10</sub> Monitoring Sites). This shows that PM<sub>10</sub> sites can be located relatively close together and not be redundant; therefore, the spatially-oriented variables were given a medium weight.



**Figure 4.5.1.** Map showing overlay of PM<sub>10</sub> scores for potential air monitoring priority.

## 4.6 PM<sub>2.5</sub> Parameter Results

### 4.6.1 Weights Used

**Table 4.6.1.** PM<sub>2.5</sub> Weights

Area	Indicator	Weights	
Source-Oriented Variables		.36	
	Emissions Inventory Point-Sources		N/A
	Arterial Road Traffic Count		.12
	Highway Traffic Count		.12
	Road Density		.12
Population-Oriented Variables		.40	
	Population Density		.19
	Minority Population Density		.21
Spatially-Oriented Variables		.24	
	Euclidean Distance Between Monitors		.10
	Standard Error from Predicted Pollution		.14
Totals		1.0	1.0

### 4.6.2 Justification

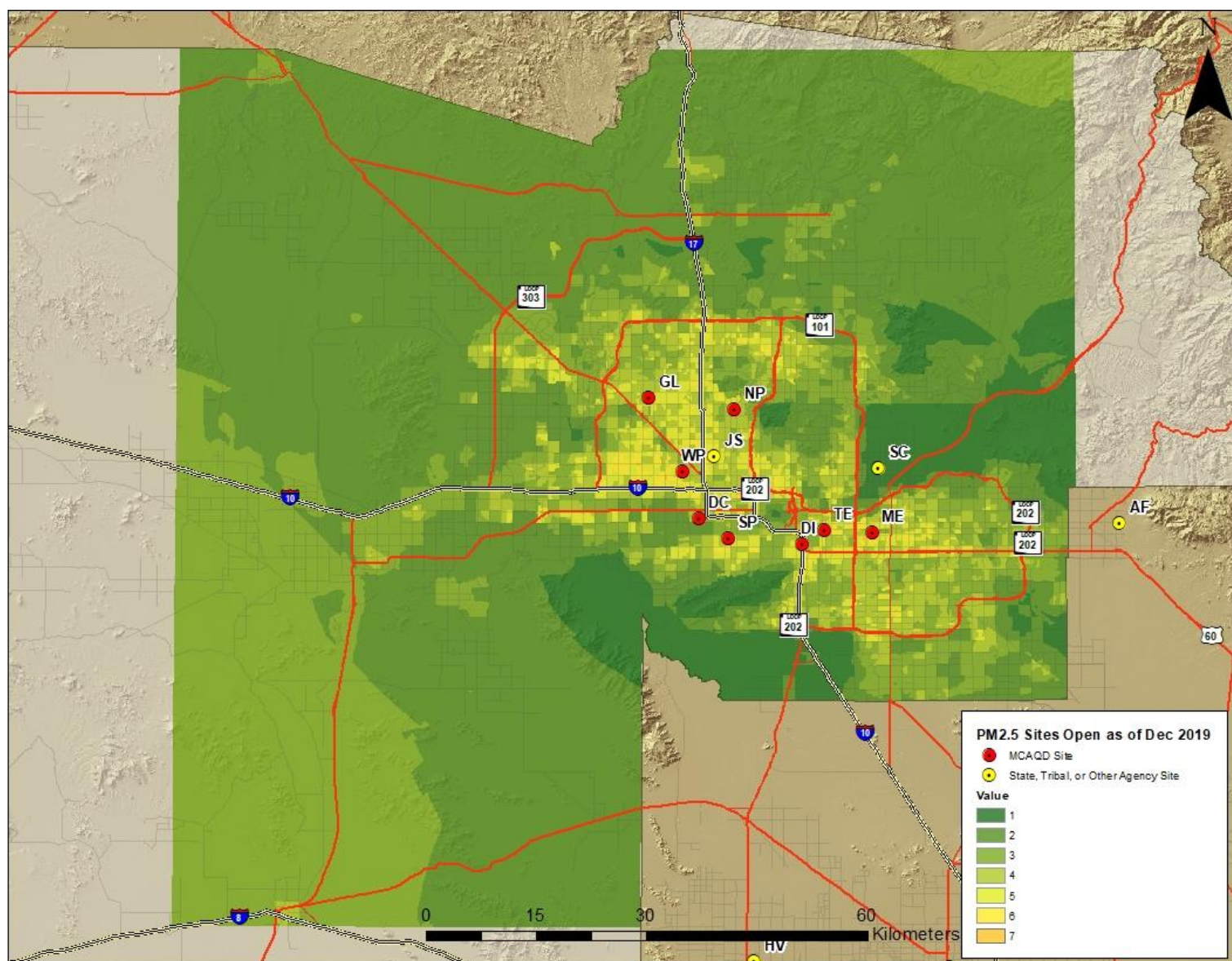
Based on the emissions inventory report, the EPA lists the major sources of PM<sub>2.5</sub> in Maricopa County as: miscellaneous, non-road equipment, road dust, industrial processes, fires, and on-road vehicles<sup>8</sup>. In this model, a relatively high weight was applied to mobile sources, because no data were available for the point-sources.

Since fires and residential wood combustion have such a high impact on PM<sub>2.5</sub> emissions, the population-oriented variables were given higher weights than source-oriented variables. PM<sub>2.5</sub> also tends to be located in urban areas with high densities of minority demographics. Because PM<sub>2.5</sub> health effects occur locally, higher weight was given to the minority population density indicator.

PM<sub>2.5</sub> monitoring sites tend to quickly lose correlation with distance (see Figure 3.7.10, Correlogram of PM<sub>2.5</sub> Monitoring Sites). This shows that PM<sub>2.5</sub> sites can be located relatively close together and not be redundant, though the Euclidean Distance indicator was not given as much weight as the source and population variables. The Standard Error indicator was given a medium weight, because the relatively low number of PM<sub>2.5</sub> monitoring sites introduces a considerable amount of error when predicting PM<sub>2.5</sub>.

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<sup>8</sup> U.S. Environmental Protection Agency (2010) Air Emission Sources, <http://www.epa.gov/air/emissions/>



**Figure 4.6.1.** Map showing overlay of PM<sub>2.5</sub> scores for potential air monitoring priority.

## 4.7 SO<sub>2</sub> Parameter Results

### 4.7.1 Weights Used

**Table 4.7.1.** SO<sub>2</sub> Weights

Area	Indicator	Weights	
Source-Oriented Variables		.38	
	Emissions Inventory Point-Sources		.18
	Arterial Road Traffic Count		.06
	Highway Traffic Count		.08
	Road Density		.06
Population-Oriented Variables		.30	
	Population Density		.15
	Minority Population Density		.15
Spatially-Oriented Variables		.32	
	Euclidean Distance Between Monitors		.16
	Standard Error from Predicted Pollution		.16
Totals		1.0	1.0

### 4.7.2 Justification

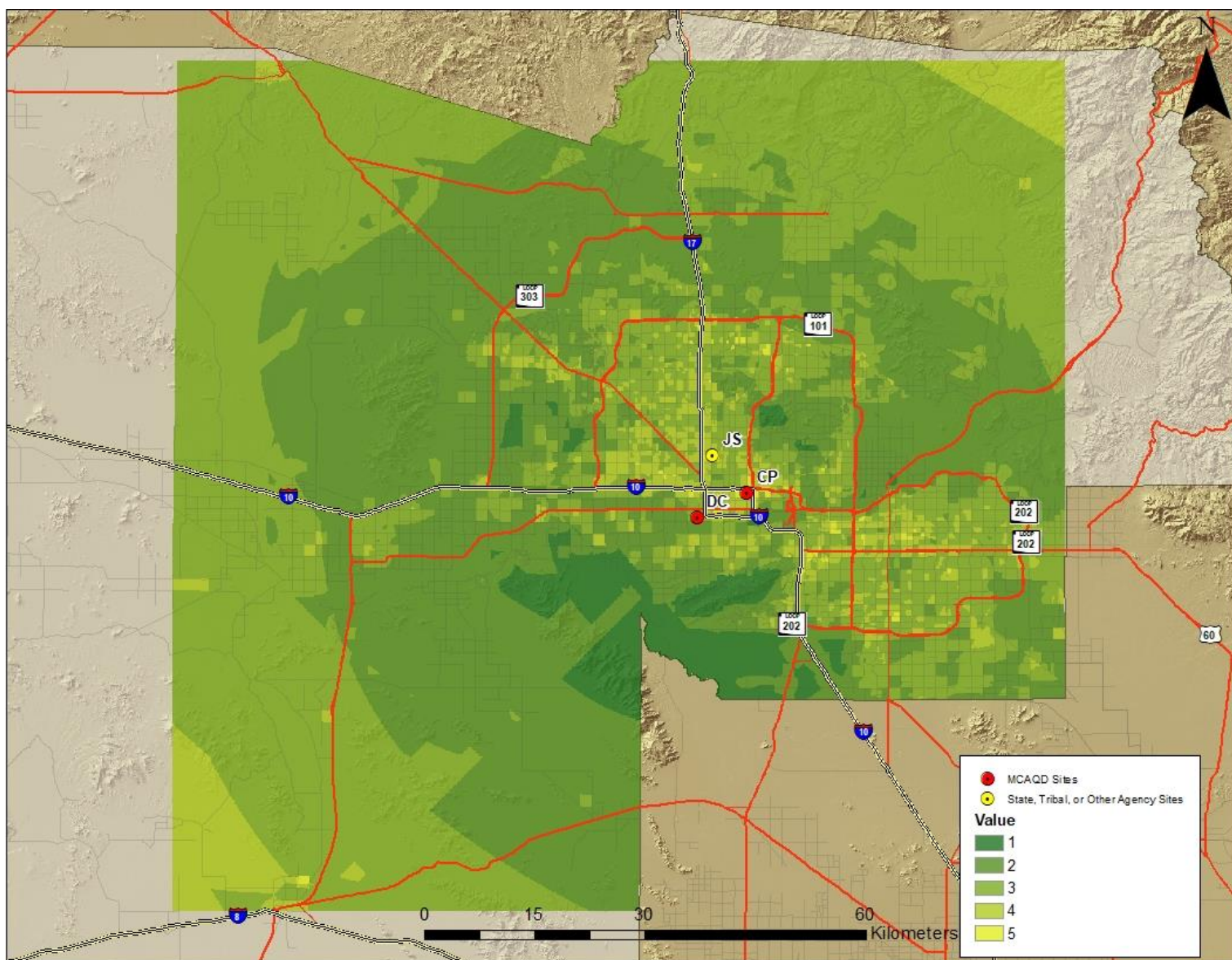
The EPA lists the major source of SO<sub>2</sub> in Maricopa County as non-road equipment, e.g. diesel-powered construction equipment<sup>9</sup>. On-road vehicles come in second with fossil fuel combustion ranking a distant third. Other processes, including industrial processes and electricity generation are insignificant in Maricopa County. There are few sources of SO<sub>2</sub> in Maricopa County; most of Arizona's SO<sub>2</sub> sources are located in the mining and smelting areas in counties east of Maricopa, which are generally downwind. This model does not have an indicator to emphasis construction sources of SO<sub>2</sub>, but mobile sources were given more weight than point-sources. Emission source variables are still given a slightly higher weight in the model.

Minority and total population indicators are given an equal weight.

The SO<sub>2</sub> monitoring sites show low correlation and little redundancy; however, this may be due to statistical error since SO<sub>2</sub> concentrations are almost at non-detect levels and the sample size is low due to only having only three monitoring sites in the county (see Figure 3.7.12, Correlogram of SO<sub>2</sub> Monitoring Sites). Although SO<sub>2</sub> concentrations show little variance, a high amount of spatial error exists due to the limited number of sites (see Table 3.3.6 for details on concentrations). Because of these dynamics, the spatially-oriented variables were given a medium weight.

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<sup>9</sup> U.S. Environmental Protection Agency (2010) Air Emission Sources, <http://www.epa.gov/air/emissions/>



**Figure 4.7.1.** Map showing overlay of SO<sub>2</sub> scores for potential air monitoring priority.

## Section 5: Findings/ Potential Changes to the MCAQD Monitoring Network

This Assessment confirms that the current MCAQD network substantially meets all federally required monitoring objectives. However, as ambient air monitoring objectives have shifted over time (e.g. air quality has improved, new air quality objectives and standards have been strengthened), MCAQD may wish to consider the findings of this Assessment during future Air Monitoring Network Planning exercises to determine whether or how to reconfigure and optimize its monitoring network to enhance its value to stakeholders, scientists and the general public.

Specifically, as a result of this Assessment, MCAQD will be informed to evaluate whether:

- unnecessary or redundant monitors for some pollutants could be removed;
- the existing network could be reconfigured to refine the monitoring of pollutants that are new or are presenting persistent challenges (e.g. ground level ozone and precursors).

This section contains suggestions for any changes to the monitoring network. Data and information from the analyses in the previous sections are used to suggest the addition, subtraction, or movement of monitors or sites. These suggestions are based upon the EPA requirements for monitoring sites, e.g. site objective and number of required sites as listed in 40 CFR Part 58. These suggestions are organized per criteria pollutant category.

### 5.1 Potential Changes to the CO Network

#### 5.1.1 Summary

- Number of existing monitors in 2019: 7
- Network changes since 2010-2014 Network Assessment:
  - Based upon the recommendations of the 2010-2014 Network Assessment and with the approval of the EPA, five CO monitors were closed in 2016. These monitors were located at the Dysart, Glendale, North Phoenix, South Scottsdale, and Tempe sites. The 2010-2014 assessment demonstrated that the CO monitoring network was redundant with very low concentrations being measured. Closing these five monitors was economically beneficial while not degrading the monitoring of CO in Maricopa County.
  - The Greenwood site was closed in 2016 and the CO monitor there was replaced by the nearby Thirty-Third near-road monitoring site that opened in 2015. However, only one CO near-road site was required in Maricopa County and this role was better fulfilled by the Diablo site, so the Thirty-Third monitor was closed in 2016. The Diablo site was shut down in early 2020 due to a freeway widening project though a new nearby site will be established with the approval of the EPA. Until that site opens, the near-road CO monitor at Diablo was moved back to Thirty-Third and began operation in early 2020.
- Monitors that may be considered for closure: None
- Monitors that should be considered to be moved or changed:
  - Move the Thirty-Third near-road monitor to the Diablo replacement site when that is opened.

Potential new monitors: None

**Table 5.1.1.** CO monitoring site summary

Site	AQS #	Objective	Scale	Notes
Buckeye	04-013-4011	Upwind Background	Neighborhood	
Central Phoenix	04-013-3002	Population Exposure	Neighborhood	
Diablo	04-013-4019	Source Oriented (Near-Road)	Microscale	Site closed Jan 2020. Will be relocated to nearby area.
Mesa	04-013-1003	Population Exposure	Neighborhood	
South Phoenix	04-013-4003	Population Exposure	Neighborhood	
Tempe	04-013-4005	Population Exposure	Neighborhood	
Thirty-Third	04-013-4020	Source Oriented (Near-Road)	Microscale	Diablo monitor moved to this site in Jan 2020.
West Chandler	04-013-4004	Population Exposure	Neighborhood	
West Phoenix	04-013-0019	Highest Concentration	Neighborhood	

### 5.1.2 Narrative

**Closing monitors:** It is not recommended to close any CO monitors at this time. The previous 2010-2014 Network Assessment recommended closing monitors to bring the network to its current size. Maricopa County is currently in attainment of the CO NAAQS and concentrations are usually quite low (the last violation of the eight-hour standard was in 1996 and the last violation of the one-hour standard was in 1984). However, Maricopa County was previously classified as serious nonattainment for CO, until it was reclassified as a maintenance area in 2005. Hence, MCAQD will be operating the CO network under a maintenance plan until 2025, see *Federal Register 70 FR 11553 (2005) and 80 FR 63185 (2015)*. The CO maintenance plan, see *70 FR 11553*, requires that the monitoring network adequately characterize the area. Because of this maintenance plan, it is not recommended to close any other CO monitors.

**Moving/changing monitors:** In late 2015, the Thirty-Third-near-road monitoring site was officially opened as the second CO near-road monitoring location in Maricopa County; the Diablo site, which opened in 2014, was the first. However, only one near-road CO monitor is required for the Phoenix metropolitan area. Diablo and Thirty-third were both reporting similar, very low concentrations of CO, though Diablo has the much higher freeway traffic volume. Because of this, and because it was the first near-road site, it was decided to close Thirty-third and keep Diablo as the required near-road site. When it was announced in 2019 that the Diablo site would need to be shut down and moved due to freeway-widening construction that was about to commence, it was decided (with concurrence from the EPA) to move the Diablo CO monitor to the Thirty-third site. Thirty-third took over near-road CO monitoring in January 2020. A nearby replacement site for Diablo has been approved by the EPA and is currently under construction. When this site is finished, estimated to be in late 2020 or early 2021, a consideration to move the near-road CO monitor from Thirty-third back to this higher traffic-volume site should be evaluated.

**Potential new monitors:** CO levels across Maricopa County are uniformly low as compared to the NAAQS and it has been over two decades since the last time the CO NAAQS were exceeded. Because of this adding new CO monitoring sites is not warranted.

## 5.2 Suggested Changes to the NO<sub>2</sub> Network

### 5.2.1 Summary

- Number of existing sites in 2019: 5 (though Diablo closed in January 2020)
- Network changes since 2010-2014 Network Assessment:
  - The Diablo NO<sub>2</sub> monitor was permanently shut down in January 2020 due to freeway-widening construction. A nearby replacement site is under construction and expected to be opened in late 2020 or early 2021.
- Monitors recommended for closure: None
- Monitors recommended being moved or changed:
  - Diablo monitor moved to replacement site when construction is finished (see narrative).
- Potential new monitors:
  - See narrative.

**Table 5.2.1.** NO<sub>2</sub> monitoring site summary

Site	AQS #	Objective	Scale	Notes
Buckeye	04-013-4011	Upwind Background	Urban	
Central Phoenix	04-013-3002	Highest Concentration	Neighborhood	
Diablo	04-013-4019	Source-Oriented	Microscale	Near-road site, closed January 2020
Thirty-Third	04-013-4020	Source-Oriented	Microscale	Near-road site
West Phoenix	04-013-0019	Population Exposure	Neighborhood	

### 5.2.2 Narrative

**Closing monitors:** It is not recommended that the closure of any NO<sub>2</sub> sites be considered. The Section 3 analyses ranked Buckeye with the lowest score; however, as there are other parameters monitored there, it incurs little additional cost to have the additional NO<sub>2</sub> monitor at the site and it provides a useful urban scale background function.

**Moving/changing monitors:** The Diablo site was closed in January 2020 due to freeway widening construction. A nearby replacement site is currently under construction and planned to be opened in late 2020 or early 2021. It is planned to move the previous Diablo near-road NO<sub>2</sub> monitor to this new site.

It is not recommended to make any changes to the objectives for the current NO<sub>2</sub> network. As demonstrated in the Section 3 Analyses, the Thirty-Third monitor has a higher design value than the Central Phoenix monitor; however, Thirty-Third is a source-oriented near-road monitor, so keeping the 'Highest Concentrations' objective at the Central Phoenix neighborhood-scale site is still appropriate.

**Potential new monitors:** Since NO<sub>2</sub> concentrations are within attainment of the NAAQS, there are no requirements to add any additional monitoring sites. In addition, the Section 4 NO<sub>2</sub> analysis returned relatively low scores for areas of potential monitoring priority and the areas with the highest scores, with a few exceptions, were usually close to existing NO<sub>2</sub> monitors. However, knowledge of NO<sub>2</sub> patterns is of special interest in researching dynamics of ozone formation. While placing a new Federal Reference

Monitor (FRM) monitor is expensive and unnecessary, using low-cost temporary sensors could potentially provide data to conduct this research. MCAQD has been assisting the EPA with research on low-cost sensors; it is recommended to either expand this program or begin a new program to place low-cost non-FRM NO<sub>2</sub> sensors in strategic areas within the Phoenix metropolitan area. In particular, areas of the east valley, e.g. Mesa and Gilbert, and the north valley, e.g. north Phoenix and Scottsdale, would benefit from low-cost temporary NO<sub>2</sub> sensors.

### 5.3 Suggested Changes to the O<sub>3</sub> Network

#### 5.3.1 Summary

- Number of existing sites in 2019: 17
- Network changes since 2010-2014 Network Assessment:
  - The Rio Verde site was closed in October 2017. Analyses from the 2010-2014 Network Assessment found that the site was redundant with other nearby O<sub>3</sub> sites and no longer representative of O<sub>3</sub> concentrations in the region. The EPA concurred with the closing of the site.
- Monitors recommended for closure: None.
- Monitors recommended being moved or changed:
  - Mesa monitor objective changed to ‘Maximum Ozone Concentration’.
  - Falcon Field objective changed to ‘Maximum Ozone Concentration’.
  - Blue Point monitor objective changed to ‘Extreme Downwind’.
- Potential new monitors: None.

**Table 5.3.1.** O<sub>3</sub> monitoring site summary

Site	AQS#	Objective	Scale	Notes
Blue Point	04-013-9702	Maximum Ozone Concentration	Urban	
Buckeye	04-013-4011	Upwind Background	Urban	
Cave Creek	04-013-4008	Maximum Ozone Concentration	Urban	
Central Phoenix	04-013-3002	Population Exposure	Neighborhood	
Dysart	04-013-4010	Population Exposure	Neighborhood	
Falcon Field	04-013-1010	Population Exposure	Neighborhood	
Fountain Hills	04-013-9704	Population Exposure	Neighborhood	
Glendale	04-013-2001	Population Exposure	Neighborhood	
Humboldt Mountain	04-013-9508	Extreme Downwind	Regional	
Mesa	04-013-1003	Population Exposure	Neighborhood	
North Phoenix	04-013-1004	Maximum Ozone Concentration	Neighborhood	
Pinnacle Peak	04-013-2005	Maximum Ozone Concentration	Urban	
Rio Verde	04-013-9706	Maximum Ozone Concentration	Urban	Closed Oct 2017
South Phoenix	04-013-4003	Population Exposure	Neighborhood	
South Scottsdale	04-013-3003	Population Exposure	Neighborhood	
Tempe	04-013-4005	Population Exposure	Neighborhood	
West Chandler	04-013-4004	Population Exposure	Neighborhood	
West Phoenix	04-013-0019	Population Exposure	Neighborhood	

### 5.3.2 Narrative

**Closing monitors:** O<sub>3</sub> is in non-attainment of the NAAQS within Maricopa County, so it is not suggested to close any existing sites as they all are important to characterizing O<sub>3</sub> concentrations.

**Moving/changing monitors:** There are several monitors in the O<sub>3</sub> network where changing environmental conditions is cause for new monitoring objectives to be evaluated. In particular, the highest O<sub>3</sub> patterns now appear to be in the east valley. The Mesa and Falcon Field sites have averaged the highest and 4<sup>th</sup> highest design value averages in the last five years, respectively. Thus, it is recommended to change their monitoring objective to ‘Maximum Ozone Concentration’ as these sites are now representative of being downwind of the urban precursor emissions area and an area of maximum ozone formation. It is also recommended to change the Blue Point site to an ‘Extreme Downwind’ objective because this site now characterizes the extreme downwind transported ozone exiting the metropolitan region.

It is not suggested that any monitors be moved at this time.

**Adding new monitors:** The various analyses show that the existing network represents the Phoenix metropolitan area in an adequate manner with the Section 4 analysis having relatively low scores. As such, it is not recommended to add new O<sub>3</sub> monitoring sites.

## 5.4 Suggested Changes to the PM<sub>10</sub> Network

### 5.4.1 Summary

- Number of existing sites in 2019: 15
- Network changes since 2010-2014 Network Assessment:
  - The Higley site was temporarily shut down in October 2014 at the request of the site owner. The site was relocated .5 km away and reopened in March 2017.
  - The Greenwood site was closed in June 2016 because of the opening of the new near-road site Thirty-Third. The 2010-2014 Network Assessment found the PM<sub>10</sub> monitor to be redundant and it was not moved.
- Monitors recommended for closure: None
- Monitors recommended being moved or changed:
  - West 43<sup>rd</sup> Avenue scale changed from Middle to Neighborhood.
- Potential new monitors: None.

**Table 5.4.1.** PM<sub>10</sub> monitoring site summary

Site	Objective	Scale	Notes
Buckeye	Population Exposure	Neighborhood	
Central Phoenix	Population Exposure	Neighborhood	
Durango Complex	Population Exposure	Neighborhood	
Dysart	Population Exposure	Neighborhood	
Glendale	Population Exposure	Neighborhood	
Greenwood	Population Exposure	Middle	Closed June 2016

Higley	Population Exposure	Neighborhood	
Mesa	Population Exposure	Neighborhood	
North Phoenix	Population Exposure	Neighborhood	
South Phoenix	Population Exposure	Neighborhood	
South Scottsdale	Population Exposure	Neighborhood	
Tempe	Population Exposure	Neighborhood	
West 43 <sup>rd</sup> Avenue	Highest Concentration	Middle	
West Chandler	Population Exposure	Neighborhood	
West Phoenix	Population Exposure	Neighborhood	
Zuni Hills	Population Exposure	Neighborhood	

#### 5.4.2 Narrative

**Closing monitors:** Maricopa County has a long history of working to comply with the PM<sub>10</sub> NAAQS and all of the existing monitors are currently useful in providing information about compliance status, so it is not suggested that any existing monitors be closed.

#### **Moving/changing monitors:**

It is suggested to change the monitoring scale of the West 43<sup>rd</sup> Avenue site from ‘Middle’ to ‘Neighborhood’. The Section 3 analysis shows relatively fair correlation between West 43<sup>rd</sup> and Durango Complex sites, which are 3.3 km apart. This correlation is likely due to the same sources impacting both sites which indicates that the monitoring scale is larger than the 100-500 meters of the ‘Middle’ classification.

**Adding new monitors:** The Section 4 analyses returned relatively low scores for the Phoenix metropolitan area and shows adequate monitoring representation. As such new PM<sub>10</sub> sites are not suggested.

### 5.5 Suggested Changes to the PM<sub>2.5</sub> Network

#### 5.5.1 Summary

- Number of existing sites in 2019: 8
- Network changes since 2010-2014 Network Assessment:
  - The Diablo near-road PM<sub>2.5</sub> monitor was permanently shut down in January 2020 due to freeway-widening construction. A nearby replacement site is under construction and expected to be opened in late 2020 or early 2021.
  - The Thirty-Third near-road PM<sub>2.5</sub> monitor was opened as a temporary site in September 2015, but then closed in March 2016 since only the near-road PM<sub>2.5</sub> at Diablo was required. When the Diablo site was closed in January 2020, the PM<sub>2.5</sub> monitor there was moved to the Thirty-Third site. Once a replacement site is found for Diablo, the near-road PM<sub>2.5</sub> monitor will be moved back.
- Monitors recommended for closure: None.
- Monitors recommended being moved or changed: None.
- Potential new monitors: None, though there are areas that could be explored with temporary or low-cost sensors to obtain more information.

**Table 5.5.1.** PM<sub>2.5</sub> monitoring site summary

Site	Objective	Scale	Notes
Durango Complex	Highest Concentration	Neighborhood	
Diablo	Source Oriented	Microscale	Closed Jan 2020, moved to Thirty-Third
Glendale	Population Exposure	Neighborhood	
Mesa	Population Exposure	Neighborhood	
North Phoenix	Population Exposure	Neighborhood	
South Phoenix	Population Exposure	Neighborhood	
Tempe	Population Exposure	Neighborhood	
Thirty-Third	Source Oriented	Microscale	Operated Sep 2015 – Mar 2016 Reopened Jan 2020
West Phoenix	Highest Concentration	Neighborhood	

### 5.5.2 Narrative

**Closing monitors:** Many of the monitors in the PM<sub>2.5</sub> network are relatively new and were situated in areas of import, such as high-density population areas or areas impacted by residential wood smoke in the winter. Even though Maricopa County is in attainment for PM<sub>2.5</sub>, there are occasional exceedances of PM<sub>2.5</sub> NAAQS and these monitors provide valuable data on the patterns of this pollutant and how we should focus our outreach and mitigation policies. Therefore, it is not recommended any PM<sub>2.5</sub> sites be closed.

**Moving/changing monitors:** The Diablo near-road PM<sub>2.5</sub> monitor was moved to the Thirty-Third site after Diablo was closed by road construction. A replacement site in the same vicinity (I-10, Broadway Curve area) as Diablo is currently being sought after with a plan to open in late 2020 or early 2021. It is suggested to move the near-road PM<sub>2.5</sub> monitor from Thirty-Third to this replacement site when it opens as traffic volumes in the I-10/Broadway Curve area are much higher than they are in the area around the Thirty-Third site (I-10 & 33<sup>rd</sup> Avenue).

**Adding new monitors:** It is not suggested to add any new PM<sub>2.5</sub> sites, however, the Section 4 analyses identified areas that could benefit from further exploration. These include areas in far west Phoenix and in central Phoenix. It is recommended to research PM<sub>2.5</sub> patterns in these areas with low-cost non-regulatory sensors (further information on these sensors will be discussed in section 5.8.1, ‘Options for New Technologies’). Research projects of this sort are currently underway in conjunction with the EPA; continuation or even expansion of the research is recommended.

## 5.6 Suggested Changes to the SO<sub>2</sub> Network

### 5.6.1 Summary

- Number of existing sites in 2019: 2
- Network changes since 2010-2014 Network Assessment: None
- Monitors recommended for closure: None
- Monitors recommended being moved or changed:
  - The Central Phoenix monitoring scale changed to ‘Urban’.

- The Durango Complex monitoring scale changed to ‘Neighborhood’
- Recommended new monitors: None

**Table 5.6.1.** SO<sub>2</sub> monitoring site summary

Site	Objective	Scale
Central Phoenix	Highest Concentration	Neighborhood
Durango Complex	Highest Concentration	Middle

## 5.6.2 Narrative

**Closing monitors:** SO<sub>2</sub> design values in Maricopa County are very low as compared with the SO<sub>2</sub> NAAQS, often staying close to the non-detect level (see Table 3.3.6); thus, when including the ADEQ’s Supersite, SO<sub>2</sub> is well represented in the area. However, the Central Phoenix site has been operating for a long time (54 years, see Table 3.2.6) and the Durango Complex site is closer to a higher proportion of SO<sub>2</sub> sources (see Table 3.9.5), so both sites have utility. Because both of MCAQD’s SO<sub>2</sub> monitors are located at sites where other parameters are monitored (see Table 3.1.6), the incremental cost of operating the monitors is lower and it is not suggested to close either one down.

**Moving/changing monitors:** SO<sub>2</sub> concentrations at the three urban monitoring sites, Central Phoenix, Durango Complex, and the ADEQ’s JLG Supersite, are consistently low and near the non-detection limit. The Section 3 correlation analysis found little correlation between the sites, but this is more likely a statistical anomaly resulting from the limited range in the concentration values versus a wide variation in the distribution. Average and maximum SO<sub>2</sub> values are very similar at all three Maricopa County SO<sub>2</sub> monitors (see Tables 3.3.6 and 3.8.6). Therefore, it is suggested to change the scale of the Central Phoenix monitor to ‘Urban’ as it is believed SO<sub>2</sub> values from this location are representative of the entire urban region. It is also suggested to change the monitoring scale of the Durango Complex monitor to ‘Neighborhood’; Durango Complex has several SO<sub>2</sub> sources within several km of the site (see figure 3.9.5) making ‘Neighborhood’ more appropriate than the current ‘Middle’ scale assigned to it.

**Adding new monitors:** It is not suggested to add any new SO<sub>2</sub> sites.

## 5.7 Suggested Changes to the Lead Network

### 5.7.1 Summary

- Number of existing sites in 2019: 1
- Network changes since 2010-2014 Network Assessment:
  - The Deer Valley monitoring site was closed in at the end of December 2019.
- Monitors recommended for closure: N/A
- Monitors recommended being moved or changed: N/A
- Recommended new monitors: None

**Table 5.7.1.** Pb monitoring site summary

Site	Objective	Scale
Deer Valley	Source Oriented	Middle Scale

### 5.7.2 Narrative

The Deer Valley Pb monitor was opened in July 2010 near the Deer Valley general aviation airport in north Phoenix, which is believed to be the largest source of Pb emissions (from leaded general aviation fuel) in the metropolitan area. Pb monitoring by Maricopa County was discontinued in 1997 because concentrations were well below the 1978 standard of 1.5  $\mu\text{g}/\text{m}^3$  per quarter. A new Pb standard of 0.15  $\mu\text{g}/\text{m}^3$  per quarter went into effect in 2008, and the Deer Valley monitor was started to ensure compliance with the new standard.

There has never been an exceedance or violation at the Deer Valley monitor and Pb concentrations monitored there have never exceeded 20-33% of the new NAAQS since monitoring commenced; e.g. the 2014 Deer Valley quarterly design value was .05  $\mu\text{g}/\text{m}^3$ . In addition, calculated emissions from the adjacent Deer Valley Airport have consistently been below the 1 ton-per-year required monitoring threshold since 2014 and therefore Pb monitoring at the site is no longer required. The ADEQ continues to operate a Pb monitor at their Phoenix Supersite, which has a similar design value as Deer Valley, and that site is now representing the Phoenix Metropolitan area for Pb monitoring. Therefore, the EPA gave MCAQD permission to cease monitoring at Deer Valley and close the site at the end of December 2019.

## 5.8 Options for New Technologies within the Monitoring Network

MCAQD is committed to keeping its monitoring network as technologically advanced as possible, budget permitting. Since the 2005-2009 Network Assessment was completed, MCAQD has upgraded all of its filter-based Federal Reference Method (FRM) particulate monitors to continuously operating Federal Equivalency Method (FEM) monitors. FEM monitors provide a more temporally detailed view of particulate pollution than FRM filter-based monitors, which typically operate on a 1-in-6 or 1-in-3 day schedule. However, continuous FEM monitors are more expensive than the filter-based monitors, and replacements were made as budgets permitted. Currently, of the 15  $\text{PM}_{10}$  monitoring sites that MCAQD operates, all are continuous FEM monitors and no filter-based FRM monitors remain. Of the eight  $\text{PM}_{2.5}$  monitoring sites, all also operate continuous FEM monitors, though one site (West Phoenix) still operates a co-located FRM filter monitor for quality assurance purposes.

Gaseous monitors are replaced and upgraded on a continuous basis. The current schedule calls for existing monitoring equipment to be replaced on a five to seven-year cycle, as budgets permit. Currently all MCAQD's gaseous monitoring equipment are classified as FRMs and are state-of-the-art equipment.

Data acquisition and management software is also maintained and upgraded regularly, with maintenance contracts automatically giving upgrades as they become available. MCAQD uses the AirVision software from Agilaire to manage its database. All monitoring network communication hardware has now been upgraded so that data from all sites are collected through high-speed network connections with repeat polling occurring on a five-minute basis. This system makes it possible to display real-time air pollution data on a web map that is accessible to the public. This real-time web map was updated in 2019 to include NowCast values (NowCast is an EPA equation that shows the relationship between short-term air pollution concentrations and longer-term NAAQS) in addition to showing a calculated AQI and raw data values. Also unique to this data management configuration is an alarm system that checks the 5-minute polled data for spikes in pollution concentrations. If an alarm is sounded, the data are checked for validity and an inspector can be dispatched to the area to attempt to mitigate any pollution-generating activities before they result in an unhealthful situation.

It is not suggested that any changes in MCAQD's current practice of technological upgrades as described above be made.

#### **5.8.1 Low-Cost Sensors**

In 2018, MCAQD began collaborating with the EPA on a pilot study called "Phoenix as a Testbed for Air Quality Sensors" (P-TAQS). This study seeks to evaluate the performance of new low-cost air quality sensors in the extreme environment of the deserts of Maricopa County. Low-cost sensors provide a method for air monitoring agencies to increase the density and spatial coverage of their monitoring networks. This technology can be useful for many things, for example:

- evaluating the existing high-quality monitoring network;
- searching or trying to understand the extent of sources of air pollutants;
- responding to citizen complaints of air pollution in unmonitored locations;
- enhancing educational outreach programs;

However, the quality of the data obtained from these sensors needs to be better understood in order to properly utilize this technology. In addition, it is unknown how the hardware units will perform over time and in relation to each other, especially considering the extreme temperatures and harsh environment that they will be operating within. The P-TAQS study is anticipated to advance knowledge on all these fronts and developing information that would be of national significance regarding both sensor performance, informing best practices for sensor networks, and providing a case study of their usefulness to a local agency.

The P-TAQS study focuses mainly on PM<sub>2.5</sub> sensors, but MCAQD has also been purchasing and experimenting with other types of low-cost sensors including ozone, NO<sub>2</sub> and PM<sub>10</sub>. MCAQD has been learning how to setup and operate these sensors and has used them on several projects, including our annual wintertime burn season study. Because of the usefulness and economy of these sensors in detecting pollution concentrations, it is recommended to continue to study their performance and utilize them in specialized projects.

#### **5.8.2 Black Carbon Sensors**

In an effort to further elucidate the impact of woodsmoke and particulate transport, especially with how this relates to their low-cost PM<sub>2.5</sub> sensors, the EPA included black carbon sensors as part of its P-TAQS study. Black carbon, also known as soot, is a component of particulate matter that is emitted when substances such as biomass or fossil fuels (e.g. in diesel engines) experience incomplete combustion. During 2019 and 2020, smoke from wildfires within Arizona, and also surrounding states such as California and Colorado, had great impact on air quality within Maricopa County. MCAQD analyses noted that data from the P-TAQS black carbon sensors, in addition to other technologies such as satellite data and transport/dispersion modelling, has proven useful as additional points of evidence in determining the impact of wildfire smoke being transported into the Phoenix metropolitan area. Therefore it is recommended to continue, and possibly expand, the use of black carbon sensors in the MCAQD network once the P-TAQS study comes to an end.

## Appendix I – Public Comments

MCAQD received two written comments on the 2019 Air Monitoring Network Review and 2020 Plan. Both comments requested the installation of new air quality monitoring sites, so the evaluation and response to these comments were deferred until after the 2020 Network Assessment was complete. The stakeholder comments and MCAQD's responses are included below.

**Comment #1:** Received June 5, 2020 from Kirk Flamm

This document is to serve as a public comment for the 2019 FINAL DRAFT Air Monitoring Network Review and 2020 Plan Public Comment Meeting during the open comment period, closing on June 10, 2020.

The review conducted of the PM10 monitoring in Maricopa County by the Air Quality Department seems to be lacking at best. The current PM10 monitors do not adequately determine any of the "site types" listed in table 4. With respect to population, the zip codes of 85086, 85087, and 85031 have a population density of over 83,000 in 2010. These population numbers are sure to show an increase with the current 2020 census, as shown by estimated growth tables from the United States Census Bureau. Transportation departments are building more infrastructure to support this migration and expansion of population. I-17 widening and interchange reconstruction at Happy Valley and Pinnacle Peak. Maricopa County Department of Transportation has built a satellite yard for material and equipment storage on Desert Hills rd to support grading of the dirt roads.

Given the unique characteristics of the geography of these zip codes, the PM10 monitors of Maricopa County do not provide a representative sample. The elevation change, hills, mountains, valleys, and wind patterns unique to this 'Urban Scale' representation with the nearest PM10 monitor, Zuni Hills monitoring at a 'Neighborhood scale' starting in 2009, more than 30 kilometers away is ineffective. These unique considerations paired with the preponderance of unpaved roads (the largest contributor of PM10 as determined by the Maricopa Association of Governments) and other dust/PM10 generating activities would give rise to significant contributions of pollution to downwind communities of Scottsdale and Paradise Valley. Further, this area with its air flow could even be sending much of its PM10 to the Fort McDowell/Yuma Frank monitor contributing to there PM10 exceedances. As an example, within these previously mentioned zip codes there is an unpaved road, Fig Springs Rd, that is over 1 mile long and has had over 900 average daily trips in the last five years. Using AP-42 emission factor to estimate the PM10 given a best case scenario, would total over 100,000 lbs of PM10 annually from this one unpaved road. By itself would be a significant source of particulate matter; then summing the unpaved roads in this area would lead one to believe there is a significant potential on PM10 in this are that is being unmonitored.

There does not appear to be an argument that additional monitoring on PM10 in this area does not have reasonable accessibility, security, and operating feasibility. Cave Creek regional park and Humboldt Mountain both have Ozone monitors. A new location that would be a good spot would be the MCDOT desert hill storage yard at the southwest corner on Desert Hills Dr and 19<sup>th</sup>. It is fenced and has power, and is owned

by Maricopa County. Daisy Mountain Fire Department has two fire houses just off New River Rd. All of these options could provide sites with the necessary physical and logistic parameters to place a monitor to determine the air quality in this area.

Thank you for your consideration.

Kirk Flamm

**Response #1:** Thank you for your comments and interest in the Maricopa County air monitoring network. Our extensive quantitative and qualitative evaluations of the PM<sub>10</sub> network done in the 2015-2019 Network Assessment demonstrate that the objectives of the current MCAQD PM<sub>10</sub> monitors do adequately meet the requirements of Table 4 of the Annual Network Plan. This evaluation also shows that there are PM<sub>10</sub> monitors in Maricopa County that can provide representative monitoring for the New River area.

For example, the PM<sub>10</sub> site with the ‘Highest Concentration’ objective is the West 43<sup>rd</sup> Avenue site. This site is located in a high-density industrial area surrounded by sources such as mining, landfills, and agriculture. The 2019 annual average PM<sub>10</sub> for all sites in the MCAQD network is 25.4 µg/m<sup>3</sup>; however, the 2019 annual average for West 43<sup>rd</sup> Avenue is 50.8 µg/m<sup>3</sup>. West 43<sup>rd</sup> Avenue also has the highest 5-year average of maximum daily values, 144.4 µg/m<sup>3</sup>. As the consistently highest-ranked site in Maricopa County for PM<sub>10</sub> concentrations, West 43<sup>rd</sup> Avenue certainly qualifies for its ‘Highest Concentration’ objective.

Evidence also shows that West 43<sup>rd</sup> Avenue is representative of the highest PM<sub>10</sub> concentrations in Maricopa County and our evaluation of existing data does not provide a conclusion that a PM<sub>10</sub> monitor in the New River area would qualify for the ‘Highest Concentration’ objective. Beside evaluating the source mixture in the area, we use the representative comparison of the PM<sub>10</sub> monitor at Saint Johns located south of Laveen on the Gila River Indian Community. Saint Johns is located in a rural area which has a population density of 25.7 people/mile<sup>2</sup>. Similar to New River, this area also has many dirt roads, though it is likely impacted to a far greater extent from agricultural sources at both the local scale and especially from nearby large sources to the south in Pinal County. The 2019 annual average PM<sub>10</sub> at Saint Johns was 25.3 µg/m<sup>3</sup>, putting it into the 66<sup>th</sup> percentile of PM<sub>10</sub> distribution at sites within Maricopa County. Since the Saint Johns site is in a rural area with a preponderance of unpaved roads and is in a similar environment as New River (other than the presence of agricultural sources), it can be postulated that the New River area would not have a design value higher than Saint Johns and therefore would not qualify as maximum concentration area within Maricopa County.

There are also currently 14 PM<sub>10</sub> sites with a ‘Population Exposure’ objective; this objective serves to measure representative concentrations in an area of high population density. Below are the population densities for the zip codes that these 14 MCAQD PM<sub>10</sub> monitors are located in:

Air Monitoring Site	Located in Zip Code	Population Density of Zip Code (People/Square Mile) *
West Phoenix	85019	7,617.8

Central Phoenix	85006	6,841.9
Glendale	85302	6,520.7
Mesa	85202	6,290.9
West Chandler	85224	4,623.0
Tempe	85281	4,508.3
South Scottsdale	85257	4,316.9
Higley	85295	3,490.0
Durango Complex	85009	3,293.2
North Phoenix	85020	3,113.1
South Phoenix	85041	3,069.5
Dysart	85378	1,958.3
Zuni Hills	85373	1,892.1
Buckeye	85326	109.4

\* Population estimates come from the U.S. Census Bureau's 2017 American Community Survey

Note that the Buckeye site exhibits a low population density because it is located within a very large zip code which is mostly uninhabited mountainous area. When evaluating the Census block groups located with 2.5 miles of the monitor (the monitoring scale of the PM<sub>10</sub> monitor), population density increases to 324 people/square mile. Also, Buckeye is a hybrid site that serves multiple purposes including as an upwind background site and a representative site for power plants and large-scale agricultural operations in the area. There are multiple monitors at Buckeye that are mainly assigned the 'Upwind Background' objective for the Phoenix Metropolitan area; the PM<sub>10</sub> monitor was not given the background objective because the extensive agriculture that surrounds the site would likely disrupt the provision of a representative background concentration.

The three zip codes in the New River area have lower population density than other areas (other than Buckeye) monitored for population exposure:

Zip Code	Total Population	Population Density (People/Square Mile) *
85086	42,569	828.9
85087	6,959	49.9
85331	30,470	238.8

\*Population estimates come from the U.S. Census Bureau's 2017 American Community Survey.

**Comment #2:** Email received 8/21/19 from Nick Kuminoff

Good afternoon,

I am writing to request that you add a permanent air quality monitoring station to western Ahwatukee to track ambient concentrations of PM<sub>2.5</sub>, PM<sub>10</sub> and ozone.

Ahwatukee is the most conspicuous “blind spot” in our county’s air quality monitoring network. The upcoming wave of 202 freeway traffic, combined with South Mountain geography, make it especially important to monitor local pollutant levels.

Thank you for considering this request.

Best regards,

Nick Kuminoff

Email reply from MCAQD on 8/22/19

Mr. Kuminoff,

My name is Ben Davis. I am in charge of operating Maricopa County’s Air Monitoring Network ( <https://www.maricopa.gov/1643/Air-Monitoring>). This network represents the Air Quality throughout Maricopa County. All changes to our Network must go through our Network Plan and Assessment process (<https://www.maricopa.gov/1669/Air-Monitoring-Network-Plans-and-Assessm>). This process does include public comments. If you need assistance, please call me on Monday.

However, I believe there is an existing air monitoring site in that general area. It is operated by the Gila River Indian Community. It is called the St Johns site and it measures ozone and PM-10.

<http://www.gricdeq.org/air-monitoring>

Ben Davis – Air Monitoring Manager

Email received 8/23/19 from Nick Kuminoff

Hi Ben,

Thanks for getting back to me, and for directing me to the Network Assessment links.

I do know about the St Johns site. However, I worry that its inadequate for two reasons. First, it does not track PM2.5 the “criteria” pollutant commonly thought to have the most pernicious effects on human health at concentrations at and below Maricopa’s current levels (e.g. <https://www.nejm.org/doi/10.1056/NEJMoa1702747>). Second, because the St Johns monitor is located on Gila River tribal land, I am not sure that NAAQS exceedances at that site would necessary trigger regulatory actions by Maricopa county to reduce Ahwatukee’s air pollution.

I spent some time working through your 2015 Network Assessment. Some of your analysis underscores my general concern about PM2.5 in Ahwatukee. For instance, I copy below your Figure 3.8.5, showing your predictive kriging interpolation map for PM2.5.

First, notice that western Ahwatukee neighborhoods sit in a “hot spot” where you predict concentrations close to the federal regulatory standard (12 ug/m<sup>3</sup>). Second, I suspect that kriging will tend to understate Ahwatukee’s true PM<sub>2.5</sub> concentrations by overweighting information from relatively clean monitoring sites on the northeast side of South Mountain. I suspect that South Mountain geography may tend to trap some air pollution in Ahwatukee neighborhoods. Third, your analysis of potentially-warranted PM<sub>2.5</sub> site rankings (page 131) notes that on-road vehicles are a major source of PM<sub>2.5</sub>. As you know, starting in early 2020 the 202 South Mountain freeway will permanently divert a large share of the valley’s mobile emissions right through Ahwatukee. Further, this diversion will likely include the vast majority of heavy duty trucking that currently goes through I-10. I think these changes make it relatively more important to track PM<sub>2.5</sub> in Ahwatukee compared to relatively clean parts of the northeast valley.

In summary, my concerns are that

1. Maricopa’s current monitoring network does not allow us to determine whether Ahwatukee’s PM<sub>2.5</sub> levels exceed the federal standard.
2. The South Mountain freeway will substantially increase Ahwatukee’s ambient PM<sub>2.5</sub> levels. This will increase the likelihood that Maricopa county violates the current federal standard for PM<sub>2.5</sub>, or lower standards that the EPA may enact in the near future as we continue to learn how PM<sub>2.5</sub> impairs human health.

Finally, will you be preparing a 2020 Network Assessment? If so, would you please give me a quick summary of the timing and process for public engagement?

Best regards,

Nick Kuminoff

**Response #2:** Thank you for your comments and interest in the Maricopa County air monitoring network. On August 21, 2019 you made a request for MCAQD to add new ozone, PM<sub>10</sub>, and PM<sub>2.5</sub> air monitors to western Ahwatukee. The response from Ben Davis, the Air Monitoring Division manager, is that all changes to the air monitoring network have to go through the annual network plans and the 5-year network assessments processes as mandated by 40 CFR 58.10. The [Annual Network Plan](#) was recently completed, submitted to the EPA and posted online at the beginning of July 2020. The 5-year Network Assessment will be completed and posted online in the coming months.

As detailed in 40 CFR 58.10(d), the purpose of the network assessment is “*to determine, at a minimum, if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation in to the ambient air monitoring network.*” The MCAQD’s Network Assessment uses a variety of techniques to prioritize and rank the effectiveness of the current network configuration and regional representation.

MCAQD’s 2015-2019 Network Assessment looked at all of the criteria pollutants currently monitored by the agency. In relation to your request for additional air

monitoring of ozone, PM<sub>10</sub>, and/or PM<sub>2.5</sub> in the Ahwatukee area, the following information was obtained:

1. Ozone: There are four ozone monitoring sites located from 9 to 38 km away from Ahwatukee Foothills (i.e. a point at Desert Foothills Pkwy & Loop 202). The South Phoenix monitoring site is also close to Ahwatukee, but as it is north of South Mountain it can be assumed to be in a separate airshed. These ozone monitors, and their distance from Ahwatukee, include:
  - a. Saint Johns 9.1 km
  - b. West Chandler 16.7 km
  - c. Tempe 18.0 km
  - d. Sacaton 38.2 km

Saint Johns and Sacaton are operated by the Gila River Indian Community (GRIC) and are not part of the Phoenix-Mesa ozone non-attainment area; West Chandler and Tempe are operated by MCAQD and are within the non-attainment area.

When analyzing 2019 annual data, these four monitors show a strong correlation with each other with Pearson correlation coefficients ranging from 67-84%. Tropospheric ozone is known to be a regionally scaled pollutant and exhibits seasonal spatial autocorrelation in the average range of 142 km<sup>10</sup>. It is very likely that the Ahwatukee area is well represented by existing ozone monitors, and perhaps has redundant monitoring, and therefore further investigation is unwarranted.

2. PM<sub>10</sub>: There are four monitoring sites located from 9-26 km away from Ahwatukee Foothills. These PM<sub>10</sub> monitors include:
  - a. Saint Johns 9.1 km
  - b. West Chandler 16.7 km
  - c. Casa Blanca 25.4 km
  - d. Maricopa 25.5 km

Saint Johns and Casa Blanca are operated by the GRIC but are also part of the Phoenix PM<sub>10</sub> nonattainment area (therefore violations at these sites have direct regulatory implications to the Phoenix nonattainment area). The Maricopa site is operated by the Pinal County Air Quality Department (PCAQD), is located in the West Pinal PM<sub>10</sub> non-attainment area and is in an area with many agricultural sources.

Annual 2019 PM<sub>10</sub> data from these four sites exhibit correlations ranging from 24-43%; however, it is the Maricopa site that shows the main differences as it is much more impacted by local sources. When Maricopa is removed, correlation between the other three sites ranges from 37-43%; average PM<sub>10</sub> correlation for sites located 25 km apart (the distance between Saint Johns and West Chandler) is 19%, so those three sites demonstrate above-average representation for the Ahwatukee

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<sup>10</sup> R. L. Pope, J. Wu, Characterizing air pollution patterns on multiple time scales in urban areas: A landscape ecological approach. *Urban Ecosystems* **17**, 855-874 (2014).

area.  $PM_{10}$  is a more localized pollutant as compared to ozone, but the average range of spatial autocorrelation on annual data is 27.2 km<sup>10</sup>. These findings suggest that the Ahwatukee area is adequately represented by the existing MCAQD and GRIC  $PM_{10}$  networks and further investigation is not necessary.

3.  $PM_{2.5}$ : The five nearest monitoring sites are located from 18-54 km away from Ahwatukee; in addition, there is a near-road freeway monitor (Diablo) located 15 km away. Diablo was recently shut down due to a freeway widening project in the Broadway curve area but is expected to open back up by the end of 2020 in a nearby location. These  $PM_{2.5}$  monitors include:
  - a. Diablo 14.7 km
  - b. Tempe 18.0 km
  - c. Mesa 22.7
  - d. Hidden Valley 45.1 km
  - e. Casa Grande Downtown 54.3 km

Hidden Valley and Casa Grande Downtown are both operated by PCAQD. Maricopa County is in attainment for  $PM_{2.5}$ , but Pinal County is still listed in non-attainment of the 2006  $PM_{2.5}$  NAAQS (though it is in attainment of the 2012  $PM_{2.5}$  NAAQS).

Although detailed spatial autocorrelation information about  $PM_{2.5}$  is not available, physical characteristics of the aerosol imply that the range of spatial autocorrelation is at least as far as  $PM_{10}$  (27.2 km) and likely much farther. However, Hidden Valley and Casa Grande Downtown are quite far away and so exhibit very little correlation with the MCAQD monitors (0.4-8%); also, the Hidden Valley site is greatly impacted from local agricultural sources and has very high  $PM_{10}$  and  $PM_{2.5}$  design values. Diablo, Tempe, and Mesa exhibit 38-43% correlation. As these sites range from 3.6 to 9.7 km apart from each other, it can be implied that they provide representation for eastern Ahwatukee, especially considering typical weather patterns. However, the local foothill topography does create some uncertainty of the monitoring representation for Western Ahwatukee.

It is important to note that other than road traffic and agricultural sources to the south in Pinal County (and perhaps to the west in the GRIC and Laveen areas), there is an appreciable lack of known significant stationary  $PM_{2.5}$  sources in Ahwatukee. Residential wood smoke is a possible source, but it is unknown how many wood-burning fireplaces or outdoor firepits there are in the area. Based upon data coming from the Diablo site, it is unlikely that freeway mobile sources in Ahwatukee will cause exceedances of the current  $PM_{2.5}$  NAAQS. The Diablo near-road site was carefully chosen as the expected area of maximum freeway emission impacts in Maricopa County; however, there has never been an exceedance of the NAAQS attributable to mobile sources at that site (there have been three NAAQS exceedances at Diablo, but these were attributed to New Year's firework smoke in two cases and a monsoon dust storm in the other). Because of this, it is unlikely that a near-road  $PM_{2.5}$  monitor in Ahwatukee would lead to any changes in the county's near-road  $PM_{2.5}$  design value. Impacts from residential and agricultural

sources, as well as blowing dust, are a possibility, however, and may warrant further investigation.

Therefore, in keeping with the mission of the network assessment to explore the incorporation of new technology into the monitoring network, it has been recommended to investigate levels of PM<sub>2.5</sub> using low-cost air sensors. These low-cost sensors do not have the quality of regulatory monitors, but MCAQD and EPA have been evaluating them for several years and correction factors have been developed that enable them to be very affordable and useful exploratory tools. There are also currently several citizen-operated low-cost sensors already in operation in the Ahwatukee area, which provide insight on PM<sub>2.5</sub> levels in the area. MCAQD can use data from these sources to ascertain if further investigation is warranted.